REMARKS

This application has been reviewed in light of the Office Action dated March 28, 2006. Claims 14-19 are presented for examination, of which Claims 14, 18 and 19 are in independent form. Claims 14, 15, 17 and 19 have been amended to define still more clearly what Applicants regard as their invention. Favorable reconsideration is respectfully requested.

Initially, Applicants note that the Examiner has again declined to consider the Supplemental Information Disclosure Statement filed in this application on March 22, 2002, and states:

> "Receipt is not acknowledged of the Information Disclosure Statement (IDS) submitted on 3/21/2002. The Office has no record of such IDS submitted on said date."

The Examiner's position is not understood. While the Office Action states that the Patent and Trademark Office has no record of having received the Supplemental Information Disclosure Statement in question, at least on March 22, 2002 (the actual date on which it was filed int eh PTO Mail Room), it is noted that the Examiner was provided with a photocopy of a return postcard, bearing the PTO Mail Room stamp, *acknowledging* receipt of the Supplemental Information Disclosure Statement on that date (and a copy of the Supplemental Information Disclosure Statement itself, as well). Applicants therefore assume that the intent of the quoted statement is that the PTO's own file of this application do not reflect the filing of the Supplemental Information Disclosure Statement apart from the mentioned copy of the postcard and of the Supplemental Information Disclosure Statement.

Applicants respectfully submit that the Examiner has misapprehended an important point: The previously submitted copy of the return postcard is *prima facie* proof of the filing of the documents listed on the postcard, on the date of the "received" stamp:

"The USPTO will stamp the receipt date on the postcard and place it in the outgoing mail. A postcard receipt which itemizes and properly identifies the items which are being filed serves as *prima facie* evidence of receipt in the USPTO of all the items listed thereon on the date stamped thereon by the USPTO.

The identifying data on the postcard should be so complete as to clearly identify the item for which a receipt is requested. For example, the postcard should identify the applicant's name, application number (if known), confirmation number (if known), filing date, interference number, title of the invention, etc. The postcard should also identify the type of paper being filed, e.g., new application, affidavit, amendment, notice of appeal, appeal brief, drawings, fees, motions, supplemental oath or declaration, petition, etc., and the number of pages being submitted. If a new application is being filed, all parts of the application being submitted should be separately listed on the postcard, e.g., the number of pages of specification (including written description, claims and abstract), number of claims, number of sheets of drawings, number of pages of oath/declaration, number of pages of cover sheet (provisional application).

The postcard receipt will not serve as *prima facie* evidence of receipt of any item which is not adequately itemized on the postcard. For example, merely listing on the postcard "a complete application" or "patent application" will not serve as a proper receipt for each of the required components of an application (e.g., specification (including claims), drawings (if necessary), oath or declaration and the application filing fee) or missing portions (e.g., pages, sheets of drawings) of an application if one of the components or portion of a component is found to be missing by the USPTO. Each separate component should be specifically and properly itemized on the postcard. Furthermore, merely incorporating by reference in the postcard receipt, the items listed in a transmittal letter will not serve as *prima facie* evidence of receipt of those items.

The person receiving the item(s) in the USPTO will check the listing on the postcard against the item(s) being filed to be sure they are properly identified and that all the items listed on the postcard are presently being submitted to the USPTO. *If any of the items listed on the postcard are not being submitted to the USPTO, those items will be crossed off and the postcard initialed by the person receiving the items.* [emphasis added]" MPEP § 503.

The previously submitted copy of the return postcard is a "record of such IDS submitted on said date", or rather on March 22, 2002. The last paragraph of the quoted portion of MPEP § 503 specifies that the PTO employee reviewing the papers filed with a return receipt

postcard will mark the postcard prior, to returning it to the applicant, to indicate any of the listed papers *not* received by the PTO. The return postcard in question was not so marked, and thus constitutes a *prima facie* showing that the Supplemental Information Disclosure Statement, a form PTO-1449, a copy of an EPO Search Report and four documents were received by the PTO. Thus, contrary to the statement in the Office Action, the PTO does have a record of the filing of that Supplemental Information Disclosure Statement, and that the filing was on March 22, 2002, and that all four cited documents were received by the PTO.

If the statement in the Office Action was simply intended to indicate that the Examiner does not have copies of the cited documents and Search Report (since a copy of the Supplemental Information Disclosure Statement and of the form PTO-1449 was submitted with the copy of the return postcard), Applicants submit herewith new copies of the two cited documents that are not U.S. patent documents, and of the Search Report.

Applicants again request that the Examiner consider and make of record the information cited in that Supplemental Information Disclosure Statement. Should the Examiner still decline to do so, he is requested in his next paper to explain his reasons fully.

In the Office Action, Claims 14, 15 and 17-19 were rejected under U.S.C. § 102 (e) as being anticipated by U.S. Patent 6,781,716 (Yoda), and Claim 16 was rejected under 35 U.S.C. § 103(a) as being obvious from that patent in view of U.S. Patent 6,571,000 (Rasmussen et al.).

Independent Claim 14 is directed to a method of performing color processing to output color data to an image processing unit, and comprises acquiring

spectral data which indicates an input color, and acquiring characteristic information of the image processing unit. A color data format of color data in accordance with the acquired characteristic information of the image processing unit is determined, to output the color data to the image processing unit. Color data having the determined color data format is generated from the acquired spectral data, and is outputted to the image processing unit. Also, according to Claim 14, the color data format includes a spectral data format, and a color component format which indicates a color using a plurality of color component data, and the generating step includes calculating the plurality of color component data from the spectral data when the color component format is determined as the color data format in the determining step.

Thus, among other notable features of a method according to Claim 14, is that a color data format that can be processed by an image processing unit is determined in accordance with character information of the image processing unit, and color data having the determined color data format is generated from spectral data to output the generated color data to the image processing unit. By virtue of this feature, this method can support various signal processing systems such as the RGB XYZ, Lab, or spectral signal processing system, because the present method involves acquiring spectral data and generating color data to be output to the image processing unit from the acquired spectral data. (Applicants note that accurate spectral data is not generated from RGB data.)

Yoda relates to color conversion in which input RGB or CMYK data is converted to Lab data using an input profile as shown in Fig. 4 or 5. The input profile is generated by a method described in col. 10, line 51, to col. 11, line 4, but it should be noted that *Yoda* does not suggest using spectral data to generate the profile. Further, the *Yoda*

system does not determine a color data format which can be processed by an image processing unit, as is recited in Claim 14. For all these reasons, Applicants submit that Claim 14 is allowable over *Yoda*.

Independent Claims 18 and 19 are computer memory medium and apparatus claims, respectively, corresponding to method Claim 14, and are believed to be patentable for at least the same reasons as discussed above in connection with Claim 14.

A review of the other art of record, including *Rasmussen*, has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as a reference against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from Claim 14, and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and allowance of the present application.

Applicants' undersigned attorney may be reached in our New York Office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,

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Anmelder/Applicant/Demandeur/Patentinhaber/Proprietor/Titulaire
CANON KABUSHIKI KAISHA

COMMUNICATION

The European Patent Office herewith transmits as an enclosure the European search report for the above-mentioned European patent application.

If applicable, copies of the documents cited in the European search report are attached.

[X] Additional set(s) of copies of the documents cited in the European search report is (are) enclosed as well.

The following specifications given by the applicant have been approved by the Search Division:

[X] abstract [ ] title

[ ] The abstract was modified by the Search Division and the definitive text is attached to this communication.

The following figure will be published together with the abstract: 1

Entered By: Q
Due: 9 / 3 / 02
Bring Up: 8 / 3 / 02

EUROPÄISCHES PATENTAMT DEN HAAG – EUROPEAN PATENT OFFICE THE HAGUE – OFFICE EUROPÉEN DES BREVETS LA HAYE

REFUND OF THE SEARCH FEE

If applicable under Article 10 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 9746

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 581 590 A (CANON KK) 2 February 1994 (1994-02-02) * abstract; figures 1,8,9; tables 3,4 * ---	1-13	H04N1/46
A	US 5 864 364 A (OBI TAKASHI ET AL) 26 January 1999 (1999-01-26) ---		
A	EP 0 616 200 A (HITACHI LTD) 21 September 1994 (1994-09-21) ---		
A	US 5 634 092 A (STOKES MICHAEL) 27 May 1997 (1997-05-27) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	18 February 2002	Kassow, H

1

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 30 9746

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-02-2002

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 0581590	A	02-02-1994	JP	6054176	A	25-02-1994
			DE	69323809	D1	15-04-1999
			DE	69323809	T2	16-09-1999
			EP	0581590	A2	02-02-1994
			US	5699489	A	16-12-1997
			US	5923824	A	13-07-1999
US 5864364	A	26-01-1999	JP	9172649	A	30-06-1997
EP 0616200	A	21-09-1994	JP	6273322	A	30-09-1994
			DE	69413277	D1	22-10-1998
			DE	69413277	T2	04-03-1999
			EP	0616200	A1	21-09-1994
			US	5547369	A	20-08-1996
US 5634092	A	27-05-1997	NONE			

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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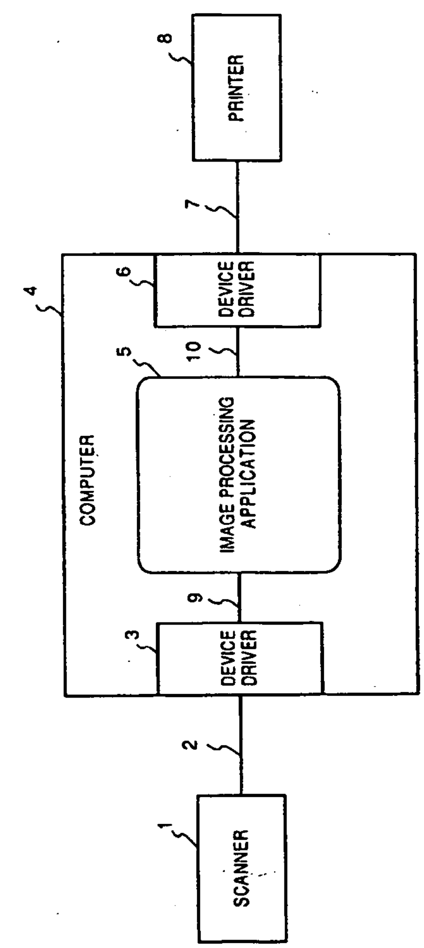
(54) Color processing method.

(57) A color processing method utilizing a plurality of devices having different color spaces as one virtual device. A scanner inquires a computer of color space and presence/absence of a color conversion function. If the computer has the color space conversion function, the scanner transmits color image data with parameters for converting the data into data of the color space of the computer. Inversely, the computer inquires the printer of color space and presence/absence of a color space conversion function. If the printer has the color space conversion function, the computer transmits color image data with parameters obtained from operation of parameters for converting the color space of the image data into the color space of the printer and the parameters received from the scanner.

FIG. 1



EP 0 581 590 A2

BACKGROUND OF THE INVENTION

Present invention relates to a color processing method for correcting the difference among color spaces of color image input/output devices. The correction is performed when the output device such as a printer outputs a color image from e.g. a computer, when a color image is inputted into a computer from the input device such as a scanner or an electronic camera, or when a computer transmits color image data to another computer.

For example, even if various devices such as a computer, a scanner, an electronic camera and a printer can represent the same RGB color-components, each device has its own sensitivity to RGB color-components. For this reason, the printed results often disagree with the users' intention. Further, in a case where a single computer selectively uses a plurality of printers, color reproduction usually differs at each printer. In this case, the printed results may be different.

To avoid such inconvenience, a computer having high-operation capability performs appropriate color correction for each device. In case of an application software, it opens the menu so that the user can select necessary color space for a current printer/scanner.

However, the conventional color correction possesses the following drawbacks:

(1) As printers and scanners increase in varieties, difficulties in Color-Space-Selection occur on the application software side.

(2) The application software operator is in charge of correction, i.e., the user should perform color correction.

These problems are serious when sharing a plurality of scanners and printers by a plurality of computers via a network.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above situation, and has as its object to provide a color processing method and color image processing apparatus which enables using a plurality of devices, each of which has its own color space, as one virtual device.

According to the present invention, the foregoing object is attained by providing a color processing method for a computer system having a plurality of device drivers respectively for image input/output devices and a plurality of color correction means for the input/output devices corresponding to the respective device drivers, the computer system processes color image data, comprising the steps of: performing color correction of the input/output devices by instructing the respective device drivers; and holding the color-corrected data by the respective device drivers.

Another aspect of the present invention aims to provide a color processing method and apparatus which enables color space conversion with high-precision.

Still another aspect of the present invention aims to provide a color processing method and apparatus which lowers load of a host computer.

The invention also provides an image processing system having a novel function and a device constituting the system.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a block diagram schematically showing the system configuration of an embodiment of the present invention;

Fig. 2 illustrates a device driver in the embodiment;

Fig. 3 is a device-independent color space control protocol in the embodiment;

Fig. 4 illustrates Color-Space-Request packet used in the color space control protocol;

Fig. 5 illustrates Color-Space-List packet used in the color space control protocol;

Fig. 6 illustrates Color-Space-Select packet used in the color space control protocol;

Fig. 7 illustrates Color-Space-Select Ack packet used in the color space control protocol;

Fig. 8 is a block diagram showing the configuration of a server/client system to which the present embodiment is applied;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described in detail in accordance with the accompanying drawings.

Normally, connection between a computer and a printer is physical connection via e.g. a cable using a centronics interface. As is apparent from a network printer connected to a local area network (LAN), it is wrong to regard a cable as a "physical and logical" connecting point. A cable is a physical connecting point, however, if it is also a logical connecting point, an application software should be able to change the physical specification of each printer or scanner.

To avoid this problem, when an input/output device provided by an input/output device maker is connected to a computer, a device driver is installed into an operating system (OS) of the computer.

The present embodiment realizes an interface between the input/output devices such as printer and a scanner by virtualizing the following four items:

(1) Logical connecting point
(2) Standard color space
(3) Virtual color correction (virtual color space conversion)
(4) Virtual Color Space Conversion Protocol

[Logical Connection]

Fig. 1 is a block diagram showing the system configuration embodying the present invention. In Fig. 1, reference numeral 1 denotes a scanner; 2, a connection cable; 3, a device driver of the scanner; 4, a computer; 5, an image processing application, e.g., a color DTP soft; 6, a device driver of printer 8; and 7, a connection cable. Device drivers 3 and 6 exist in the computer 4 and they are connected via programmable connection paths 9 and 10 to each other.

Conventionally, a color image data interface is defined by physical connecting points (cables 2 and 7) between the input/output devices 1 and 8. In the present embodiment, however, the interface is defined by logical connecting points (paths 9 and 10). More specifically, the device driver 3 exists in the computer 4 physically, however, the device driver 3 can be logically considered as a part of the scanner 1. Also, the device driver 6 which exists in the computer 4 physically can be regarded as a part of the printer 8.

Accordingly, the difference of color space between the computer 4 and the scanner 1 or the printer 8 can be easily corrected by using the interfaces 9 and 10 between the device drivers 3 and 6 as logical connecting points for color correction. The connection paths 9 and 10 will be referred to as "logical connecting points" hereinafter.

In this embodiment, the respective logical connections are provided with standard color space around them. If the computer 4 uses RGB color space and the printer 8 uses YMC color space, the device driver 6 performs RGB→YMC conversion.

[Color Correction at Logical Connecting Point]

The color correction at a logical connecting point can be applied not only to the color space conversion between different color spaces, but to conversion between the same color spaces. For example, the scanner 1 normally outputs RGB signals and the computer 4 often uses RGB color space as its standard color space. In many cases, the white balance of the scanner 1 and that of the computer 4 are subtly different. Conventionally, the user has manually adjusted such subtle difference or has done nothing and abandoned the difference. Assuming that the color space of the scanner 1 is R'G'B', correction to the scanner 1 color space should be made by the device driver 3. That is, color correction should be preferably performed at a logical connecting point.

[Introduction of Standard Color Space]

As described above, it is not appropriate to assume the color space of the scanner 1 "R'G'B'" and that of the computer 4 "RGB", since a well-designed standalone scanner performs color correction before it outputs a color signal. If the scanner color space RGB is standard, the computer 4 color space should be non-standard. Unfavorably, the misunderstanding that computers always have standard color space derives from the fact that they treat digital numerical values while scanners including a light source and a image sensor treat analog values. In fact, however, a color based on a value set on the computer is unknown until the data is displayed on a CRT display and becomes visible color to human eyes. For this reason, the computer numerical values cannot be determined correct unless the CRT display is properly adjusted. Usually, color correction is performed at the devices not in a computer, because the computer controls all the devices and therefore the color correction cannot be performed in the computer. In this case, however, the color correction is performed on the assumption that the computer has correct color space.

[Contradiction in Color Correction by Computer]

As in many systems, it is convenient to perform final color correction by a computer. However, it is very incredible considering the above-mentioned fact that computer do not always have correct color space. For example, in an application software, a scanner can be driven using a command in the menu. It seems very convenient because the application can directly drive the scanner. In fact, a long list of scanners is displayed in the menu, then a corresponding scanner is selected, and scanning is started. As this selection is made only once, there seems no problem. However, problems occur in the following cases.

The scanner selection by the application software means the application softwares are in charge of setting the various scanners. Also color correction should be made by the application software. When there existed only a few types of black-and-white scanners in the market, an application software was able to perform color correction. Now there are variety of scanners such as a scanner for black-and-white half-tone and a color scanner, color correction by the application is insufficient. Device driver should clarify that the scanner side should be in charge of color correction. Even in a case where a system can provide only one scanner to a user, the system should have a construction connectable to a scanner of any type without adjustment.

[Setting of Standard Color Space]

In the present embodiment, standard color space is provided at the logical connecting points in order to solve the above-mentioned problems and contradiction. Equation 1 is for converting color space "R'G'B'" into color space "RGB". $[f_{11}, f_{12}, \ldots, f_{33}]$ is a conversion coefficient matrix. Equation 2 is for converting color space "RGB" into "rgb". $[g_{11}, g_{12}, \ldots, g_{33}]$ is a conversion coefficient matrix.

Equation 3 is obtained by substituting the equation 1 into the equation 2. The conversion coefficient matrix of the equation 3 is replaced with equation 4, and the equation is expressed as equation 5. This means that once matrix operation is performed, the number of color conversion operations which should initially be performed twice can be reduced to once. The conversion coefficient matrices $[f_{11}, f_{12}, \ldots, f_{33}]$ and $[g_{11}, g_{12}, \ldots, g_{33}]$ are represented as [F] and [G] in equations 6 and 7 for the sake of simplicity.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad \ldots (1)$$

$$\begin{bmatrix} r \\ g \\ b \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad \ldots (2)$$

$$\begin{bmatrix} r \\ g \\ b \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{bmatrix} \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix}$$

...(3)

$$\begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{bmatrix} \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix}$$

...(4)

$$\begin{bmatrix} r \\ g \\ b \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad \ldots(5)$$

$$(F) = \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix} \quad \ldots(6)$$

$$(G) = \begin{bmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{bmatrix} \quad \ldots(7)$$

$$\begin{bmatrix} r \\ g \\ b \end{bmatrix} = (D) \quad (G) \quad (F) \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad \ldots(8)$$

Fig. 2 shows the color space characteristics of the computer 4. In Fig. 2, the elements in Fig. 1 have the same reference numerals. Reference numeral 11 denotes a color space characteristic of the scanner; 12, a standard color space characteristic; 13, a color space characteristic of the computer. These color space characteristics are represented as "R'G'B'", "NTSC RGB", and "r'g'b'" respectively. "G" is a conversion means (matrix) for converting "R'G'B'" data into "NTSC RGB" data. "F" is a conversion means (matrix) for converting "NTSC RGB" data into "r'g'b'" data.

Any appropriate color space can be employed as the standard color space here. If the data transmitting side (scanner 3) and the receiving side (computer 5) both have "RGB" color space, it should be desirably "NTSC RGB". The transmitting side converts the device color space data "R'G'B'" into the standard color space data "NTSC RGB" by the conversion means "G". The receiving side converts the standard color space data "NTSC RGB" into the device color space data "r'g'b'" by the conversion means "F".

[Virtual Color Correction (Virtual Color Space Conversion)]

The two conversion means "G" and "F" are indispensable for setting the standard color space. However,

there are the following problems:

(1) The cost of the entire system increases.
(2) The throughput is degraded.
(3) Operation errors accumulate at every conversion.
(4) Color representation dynamic range becomes narrow at every conversion.

To avoid such problems, the Virtual Color Correction Concept (Virtual Color Space Conversion) is introduced in the present embodiment. The Virtual Color Correction/Virtual Color Space Conversion (hereinafter referred to as "virtual conversion") is a method for transmitting as one set an equation for converting color space into a target standard color space and initial data without operating the equation. In this method, the final operation is entrusted to the receiving side. The receiving side first operates the conversion means G and F, and multiplies the result with the initial data value. This reduces the number of the matrix operations (twice) to only once, and preventing operation errors such as a rounding error. Note that the operation is entrusted to the data receiving side only if the receiving side has the operation function. If the receiving side does not have the function, the operation is performed on the transmitting side.

[Virtual Color Space Conversion Protocol]

Fig. 3 shows Virtual Color Space Conversion Protocol in the present embodiment. The communication between the transmitter and the receiver is performed via device drivers, and the protocol is realized by packet transmission. For example, in a case where the transmitter and the receiver perform communication within one personal computer, only a packet pointer is transmitted and an actual packet is not transmitted.

Figs. 4 to 7 show the construction of respective packets. It should be noted that the constructions are similar to each other and therefore only Color-Space-Request packet shown in Fig. 4 will be described here. The packet includes one-byte base elements, packet ID 41, command ID 42, length 43, and content 44 from the top. The packet ID 41 has a code indicative of the type of the packet. The command ID 42 has a code indicating what the subsequent data elements represent. The length 43 shows the length of the content 44 in byte units. The command ID 42, the length 43 and the content 44 can be repeated depending upon circumstances. Terminator 45 is included at the end of the packet. The terminator 45 is a kind of command ID and is indicative of "0". The content 44 is a variable-length data whose length is defined in byte units by the length 43. Note that although the variable-length content 44 has expansivity, the content 44 can be fixed-length data.

The Virtual Color Space Conversion Protocol shown in Fig. 3 will be described below. First, the transmitter transmits the Color-Space-Request packet to the receiver, to specify the color space of image data to be transmitted and inquire of the receiver's color space. At the same time, the transmitter informs the receiver of presence/absence of a color conversion function. As shown in Fig. 4, the transmitter transmits data in accordance with "RGB" color space, and informs that there is no color conversion function ("No") on the transmitting side. On the other hand, the receiver returns a Color-Space-List packet to the Color-Space-Request packet, to inform the transmitter of a list of acceptable color spaces. As shown in Fig. 5, the receiver receives in accordance with "RGB" color space and informs that there is a color conversion function ("Yes") on the receiving side.

The transmitter transmits a Color-Space-Select packet as shown in Fig. 6 to determine the color space and data format to be used. For example, the employed color space data is "RGB" and the data is to be transmitted with virtual color correction parameters. This packet includes filter coefficients for color space correction. The receiver acknowledges the color space and the data format to be used by Color-Space-Select Ack packet as shown in Fig. 7. The transmission can be made without acknowledgment, and the Color-Space-Select Ack packet can be optional.

Next, a case where scanners and printers are connected to a computer via a network will be described. In this example, the transmitter is a Macintosh by Apple Computer (hereinafter referred to as "S/P Client"), the receiver is a standalone network scanner printer server (hereinafter referred to as "S/P Server"). In this system, the transmitter and the receiver are connected via a communication protocol. Generally, the Local talk is used for Macintosh, however, to have the machine coexist with e.g. the UNIX environment represented by the SUN, the TCP/IP protocol is suitable. For this reason, the MacTCP which is the TCP/IP protocol for Macintosh is employed as the communication protocol in this system.

The functional elements in this system are PrintTCP, the SP Client, the SP Server, and the MacTCP.

The PrintTCP and the SP Client and the MacTCP are installed into the Macintosh. The PrintTCP is a scanner printer driver for outputting data to a scanner printer server on the Ethernet via the TCP/IP from an application of the Macintosh. The basic functions of the PrintTCP is as follows:

(1) To generate, when the QuickDraw subroutine is called upon printing, a CaPSL (Canon Printing System Language) code equivalent to the subroutine. The CaPSL is a printer language by Canon K.K.
(2) To generate, as a CaPSL code, bit map halftone image data (color/black-and-white) compressed by

the ADCT (Adaptive Discrete Cosine Transformation) transformation based on the JPEG (Joint Photographic coding Experts Group) standards as an optional function.

(3) To transmit the generated CaPSL code to the S/P Server via the S/P Client driver.

The SP Client is a communication control program for transmitting a CaPSL code to the printer connected to the S/P Server via the TCP/IP and the Ethernet. The SP Client has the following basic functions:

(1) To link end-to-end the S/P Client and the S/P Server via the TCP/IP.

(2) To transmit CaPSL data received from the PrintTCP to the S/P Server.

(3) To have the S/P Server scan an original, then receive the scanned data, and transmit the received data to the application.

The SP Server always runs on the S/P Server as a demon, while waiting for data reception from the client. The basic functions of the SP Server are as follows:

(1) To pass the CaPSL data from the S/P Client to CaPSL interpreter.

(2) To start an original scanning program and transmit received scanned data to the S/P Client.

Fig. 8 shows the relation between these programs. The format and function of the resources of the respective program units are as follows:

(1) Printing Manager: to call a subsequent printer driver installed in the system as a standard driver. Type = DRVR, iPrDrvRef = -3

(2) PrintTCP: initially this printer driver is not installed in the system. It is provided as a code resource in the form of Chooser Document so as to be selected from the Chooser DA with Laser Writer and Image Writer.

(3) SP Client: this driver automatically installs itself in the system by INIT-31 mechanism upon starting of the system.

(4) MacTCP: this driver also has the resource "Control Panel Document". It sets initial values such as IP address from the control DA.

(5) SP Server: It is a FSX server side program which exists in the form of e.g. a demon of the UNIX.

In Fig. 8, reference numeral 20 denotes a DTP application on the market; 21, the Printing Manager which always exists in the OS; 22, the PrintTCP; 23, the SP Client; 24, the MacTCP; 25, an Ethernet board; 26, a control function of ADCT board; 27, an ADCT compression board; 28, an Ethernet Cable; 29, an Ethernet board; 30, the TCP/IP protocol which always exists in the UNIX; 31, the S/P server; 32, the CaPSL interpreter; 33, a control function of the ADCT board; 34, an ADCT compression board; and 35, the printer. Numerals 20 to 25 denote the Macintosh; 29 to 34, NWSP; 25 and 29, hardware for providing a communication function via the cable 28. Actual logical communication path can ensured by the MacTCP 24 and the TCP/IP 30. The SP Client 23 and the SP Server 31 form an end-to-end printer server/client protocol on a logical communication path provided by the TCP/IP 30. The purpose of this protocol is to serve as a driver to divert the application 20 from its attention to the network (Ethernet) and have the application regard the printer 35 as if it is connected to local computers. In other words, to the application 20, the printer 35 seems directly connected under the Printing Manager 21.

Fig. 9 shows in detail the relation between the computer side and the OS 36. As shown in Fig. 9, the Printing Manager 21 is a part of the OS 36. The PrintTCP 22 and the SP Client 23, the SP Client 23 and the Mac TCP, the PrintTCP and the control function 26 perform communication via a device manager 37. The PrintTCP 22 is divided into QuickDraw-CaPSL converter 22-1 and printer driver 22-2. The converter 22-1 replaces the QuickDraw subroutine with a CaPSL code. This operation enables the SP Server having the CapSL interpreter to emulate the QuickDraw in place of the QuickDraw. Constructing the system using the respective drivers as drivers not applications provides the greatest merit of easy standardization of specification, since the interface is connected via the OS 36. Further, if the OS is actually a single task OS, though the OS is the Multifinder, drivers at the corresponding parts can be multitasked. For example, in case of the UNIX, only an interface to a physical device can be a driver and the other interfaces can be demons to run on the background.

[SP Client Format]

The SP Client driver automatically installs itself in the system by the INIT-31 mechanism upon turning on the power. When the driver memory size becomes greater, most codes are held in the form of code resource, and when the driver is opened, the resources are loaded on the system heap. In this case, the memory is freed when closing. The driver name begins with a period (".").

Further, the SP Client has the Control Panel Document resource. It can set various parameters such as the IP address from the Control Panel. For this purpose, it has resources as follows:

DITL ID = -4064
mach ID = -4064

nrct ID = -4064
ICN# ID = -4064
BNDL ID = -4064
FREF ID = -4064
cdev ID = -4064

[SP Client Driver Interface]

The SP Client provides the following hi-level deice manager routines:

DriverOpen
DriverClose
Control
FSRead
FSWrite
Status
KillIO

Other services of the SP Client than the above in the standard driver interface can be provided by Control routine. Various commands as listed below can be used by setting a cs code of the Control call's parameter block to a predetermined value:

SPSetInit
SPListen
SPCapability
Color-Space-Request
Color-Space-List
Color-Space-Select
Color Space Ack

[Explanation of Commands]

The commands are as shown in table 1.

Table 1

DriverOpen	<item>	<define>	<content>	<example,comment>
	parameter	host	host name	
		wind	window size	(1,2,3,4)
		*buffer	buffer pointer	(SPOpen result)
	return:	OsErr	result	
		refnum	port ref.No.	(hereinafter this No.)
DriverClose	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
	return:	OsErr	result	
FSRead	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
		*buffer	buffer pointer	(received data buffer)
	return:	OsErr	result	
		RxSize	data size	(received data size)
		EOF	End of File	data termination flag
FSWrite	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
		*buffer	buffer pointer	(transmission data buffer)
		size	data size	(transmission data size)
		EOF	End of File	(data termination flag)
	return:	OsErr	result	
Status	<item>	<define>	<content>	<example,comment>
	parameter	host	host name	
		*buffer	buffer pointer	(SPStatus result)
	return:	OsErr	result	
Control	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
		*buffer	buffer pointer	(data buffer)
		size	data size	(data size)
	return:	OsErr	result	
SPInit	csCode=cSPInit	server first issues it & prepares reception		
	<item>	<define>	<content>	<example,comment.
	parameter	host	host name	
		Wind	window size	(1,2,4,8)
		*buffer	buffer pointer	(SPOpen result)
	return:	OsErr	result	
		refnum	port ref.No.	(hereinafter this No.)
SPListen	csCode=cSPListen	server issues it & acknowledges reception		
	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
	return:	OsErr	result	
SPSetStatus	csCode=cSPStatus	server issues it & changes S/P server setting		
	<item>	<define>	<content>	<example,comment>
	parameter	refnum	port ref.No.	
		newStatus	new status setting value	
	return:	OsErr	result	

[Packet Format]

General packet format of the SP Server/Client protocol is as shown in Fig. 10. In Fig. 10, numerals allotted at the left side indicates the number of bytes.

[Packet Functions]

The functions of the SCCL packet and the DVCL packet are as shown in Tables 2 and 4.

Table 2

OpenConn	set server/client link, ensure virtual communication line inform server/client communication function to opposite end
Open ConnReply	acknowledge server/client link acknowledge server/client link communication function establish connection number (Conn-ID)
CloseConn	disconnect server/client link
Data	data
Ack	acknowledge data transmission
Nack	acknowledge data transmission, control flow
Status	inquire of server/client link status
StatusReply	reply to Status; one of RR, RNR, Status ACK,Abort
Abort	disconnect communication
Control	control server/client (all services except data to PrintTCP)

Table 3
<DVCL Packet>

Init(com-id=fxInit) device=<device-name> direction=<data-direction> PDL=<language> paper=<paper-size> scape=<scape-type> resolution=<dpi> color=<color-space>	:SPServer initialization request (e.g. Print,Scan,Get,Give) (e.g. CaPSL,Postscript,HPGL) (e.g. A4,A3) (e.g. Landscape,Portrait) (e.g. 100,200,300,400) (eg.BK,RGB,RGBX,CMYK,LAB,XYZ,YCrCb)
InitAck(com-id=fxInitAck) result=<result-code>	:SPServer initialization response (e.g. noErr,Error)
Scan(com-id=fxScan) paper=<paper-size> scape=<scape-type> resolution=<dpi> color=<color-component>	:scanning start request (e.g. A4,A3) (e.g. Landscape,Portrait) (e.g. 100,200,300,400) (e.g. R,G,B,C,M,Y,K,X,)
ScanAck(com-id=fxScanAck) result=<result-code> which-image=<image-id>	:scanning start response (e.g. noErr, Error) (e.g. 1, 2, 3...)
Print(com-id=fxPrint) paper=<paper-size> scape=<scape-type> resolution=<dpi> color-compo=<color-component> pages=<number-of-pages>	:printing start request (e.g. A4, A3) (e.g. Landscape, Portrait) (e.g., 100, 200, 300, 400) (e.g. R,G,B,C,M,Y,K,X) (e.g. 1-99)
PrintAck(com-id=fxPrintAck) result=<result-code> which-image=<image-id> queue-number=<number>	:printing start response (e.g. A4, A3) (e.g. 1,2,3...) (e.g. 1,2,3...all)
Capability(com-id=fxCapability)	:SPServer function acknowledgment request
CapabilityAck(com-id =fxCapabilityAck) device=<device-name> direction=<data-direction> PDL=<language> paper=<paper-size> scape=<scape-type> color=<color-space>	:SPSserver function acknowledgment response (e.g. Print,Scan,Get,Give) (e.g. CaPSL,Postscript,HPGL) (e.g. A4,A3) (e.g. Landscape,Portrait) (eg.BK,RGB,RFBX,CMYK,LAB,XYZ,YCrCb)
SetArea(com-id=fxSetArea) area=<print-area>	:original image effective area setting request (e.g. top,lef,bottom,right)
SetAreaAck(com-id=fxSetAreaAck) which-image=<image-id> result=<result-code>	:original image effective area setting response (e.g. 1,2,3...) (e.g. noErr,Error)
SetColor(com-id=fxSetColor) which-image=<image-id> color=<color-space> color compo=<color-component>	:color designation request (e.g. 1,2,3...) (eg.BK,RGB,RGBX,CMYK,LAB,YXZ,YCrCb) (e.g. R,G,B,C,M,Y,K,X)
SetColorAck(com-id=fxSetColorAck) result=<result-code>	:color designation response (e.g. noErr,Error)
BufFlush(com-id=fxBufFlush) which-image=<image-id>	:image memory clear request (e.g. 1,2,3...)

BufFlushAck(com-id=fxBufFlushAck) result=<result-code>	:image memory clear response (e.g. noErr,Error)

Table 4

ClearQueue(com-id=fxClearQueue) queue-number=<number>	:printer queue clear request (e.g. 1,2,3...all)
ClearQueueAck(com-id =fxClearQueueAck result=<result-code>	:printer queue clear acknowledgment (e.g. noErr,Error)
Comp(com-id=fxComp) which-image=<image-id> type=<compression type>	:image compression request (e.g. 1, 2, 3...) (e.g. JPEG, MH,MR,MMR)
CompAck(com-ide=fxCompAck) which-image=<image-id> result=<result-code>	:image compression acknowledgment (e.g. 1,2,3...) (e.g. noErr, Error)
Dccomp(com-id-fxDecomp) which image=<image-id> type=<compression type>	:image expansion request (e.g. 1, 2, 3...) (e.g. JPEG,MH,MR,MMR)
DeCompAck(com-id=fxDeCompAck) which-image=<image-id> result=<result-code>	:image expansion acknowledgment (e.g. 1,2,3...) (e.g. noErr,Error)
DIR(com-id=fxDIR)	:directory request
DIRAck(com-id=fxDIRAck) directory=<directory>	:directory response (e.g. /home/user-name/file-name)
CD(com-id=fxCD) directory=<directory>	:directory change request (e.g. /home/user-name/file-name)
CDAck(com-id=fxCDAck) result=<result-code>	:directory change response (e.g. noErr,Error)
Get(com-id=fxGet) data=<data>	:file transmission request
GetAck(com-ide=fxGetAck) result=<result-code>	:file transmission acknowledgment (e.g. noErr,Error)
Put(com-id=fxPut) data=<data>	:file reception request
PutAck(com-id=fxPutAck) result=<result-code>	:file reception acknowledgment (e.g. noErr,Error)
Cancel(com-ide=fxCancel) result=<result-code>	:scanner server operation, setting cancellation (e.g. noErr,Err)
Color-Space-Request(com-id=Color- Space-Request) Color Space Capability	:transmitter's color space request and color processing function color space name color processing capability
Color-Space-List(com-id=Color- Space-List Color-Space Capability	:receiver's color space list and color processing function color space name color processing capability

Color-Space-Select(com-id=Color-Space-Select)	:transmitter's color space designation and color processing method designation
Color-space	color space name
Color-Method	color processing method
Color-Space-Select Ack(com-id =Color-Space-Select Ack)	:receiver's color space acknowledgment and color processing method
Color-space	color space name
Color-Method	color processing method

Figs. 11 and 12 show the sequence of these packets and commands. Fig. 11 depends upon the flow between a client and a server. Fig. 12 depends upon the flow between the MacTCP and the SP Client.

Similarly to standard file access, access from the application side are made using Open, Read, Write and Close commands. First, the PrOpen function is called from the application. The SP Client receives the SPOpen command, and it issues the TCPActivateOpen function by the Connect command to be connected with the TCP/IP. The SP Client indicates that the call of the TCP/IP has been normally set if the return of the function is "noErr". The SP Client subsequently transmits the OpenConn packet to the SP Server to link the SP Client and the SP Server on the set TCP link. The SP Server returns the OpenCopnnReply to acknowledge the setting of the session link unless there is no problem in the printer. Thereafter, the SP Client transmits the Init packet and the Control packet to the server side to initialize the parameters of the server side. Then, the SP Client issues the Color-Space-Request packet for color space control. The subsequent communication has been already described. These SP Server/SP Client packets are transmitted by TCPSend or TCPRv packets of the TCP/IP protocol.

[Modification]

Figs. 13 and 14 show a modification to the present embodiment. Fig. 13 shows image information displayed on a CRT monitor. In Fig. 13, reference numeral 50 denotes the CRT monitor; 51, a corrected color signal for displaying correct NTSC RGB color on the monitor; "D", a correction coefficient matrix; and 52, a connection cable. In order to display the RGB signal which is "proper" to human eyes, color correction such as gamma (γ) correction is required. In Fig. 13, gamma correction is performed on the computer side. As it takes a long period to perform such correction by a CPU, it is usually made on the monitor 50 side, as shown in Fig. 14. The scanner color signal is multiplied by the correction coefficient matrix D on the monitor side. Generally, a color correction circuitry of a monitor has a hardware construction, or it is a high-speed processor such as a DSP (Digital Signal Processor) for high-speed correction. In any case, to the computer side, the CRT has conventionally been a passive device which simply reproduces a given RGB signal. In other words, the coefficient matrix D has been the CRT monitor 50's own color processing system included in the monitor 50, and has never been directed to the computer for its dynamic use in frequent operation (except setting correction).

The device-independent color processing method according to the present invention can even omit the image processing operation by the CPU of the computer while the interface passes a color signal according to a virtual standard color space to the CRT monitor. Actually, the input-side color correction coefficients as the equation 4 and those of the scanner in Fig. 2 can be transmitted separately from the image signal, in the form of protocol, to the CRT monitor. Equation 8 shows this processing. "F" denotes a correction coefficient matrix for matching the scanner's own color space to the standard color space; "G", a correction coefficient matrix in the computer; and "D", a correction coefficient matrix for matching the monitor's own color space to the standard color space. If the CRT monitor is an active device as that in the present invention, the color correction operation can be made by the final device at a time as the equation 8.

In this manner, the present invention realizes a color processing system which optimizes hardware resource for high-speed operation while containing the device-independent concept, further, reduces accumulative errors of the operation.

It should be noted that the algorithm having cascade-connected filter operations so as to perform the operation at a time within the final device can be easily made when color correction is established between the three primary color representation (color mixing system) such as "RGB", "XYZ", "CMY" and "YIQ". However, in case of conversion between one of the above color systems and a color representation calculated from the XYZ system (color developing system) such as "L*a*b*", the operation based on the above algorithm cannot be performed easily. Rather, in such case, the color mixing system should be converted into the color developing system before operation.

[Color Correction]

When a computer-processed color image is printed, whether the printed result coincides with the color on a CRT monitor or not is a significant problem. In a computer-processing system, the monitor and the printer are adjusted in the following manner.

In standard monitor adjustment, based on the assumption that the respective RGB color-components vary from 0 to 100, a "RGB = 100,0,0" signal is inputted to display red, and the displayed red color is measured by a spectrophotometer. The measurement result obtained as a "XYZ" signal is converted into a RGB signal. The "R" signal gain is adjusted to "100, 0, 0". Similarly, a "RGB = 100, 100, 100" signal is inputted and adjusts so that the output of the spectrophotometer will become "100, 100, 100". Next, a half tone color signal such as "RGB = 70, 30, 30" is inputted and adjustment is performed in a similar manner, and finally, a signal "RGB = 70, 70, 70" is inputted as white balance to complete adjustment. Regarding printer adjustment, the basis of the adjustment method is correspondent to the above method. It goes without saying that there are other applicable adjustment methods.

Once the monitor and the printer are respectively adjusted, the corrected values become unchanged. Even through this adjustment stage, the CRT monitor display and the printed result may be different. Printing experts take this very seriously. To solve this problem, electronic color codes have been introduced. The electronic color codes are provided by printing ink makers, with computer color samples (color image data) so that colors the same as their ink-printing color samples can be obtained on computer display. When a color image data is formed on a computer and finally printed out, referring to the electronic color codes is inevitable for the accuracy of the work. The electronic color codes are provided in the form of application, or provided as the document file of a popular application soft to be compared with attached color samples. Accordingly, the application's hue adjustment function requires minute adjustment. However, a plurality of applications, a plurality of ink makers, a plurality of color samples, and combinations thereof, will make such adjustment confusing.

Setting of adjustment values can be made by a utility program or by a DTP application. However, the adjustment results should not be managed by the application but by a device driver so as to avoid color correction for every color sample at every application. According to the embodiment, a color image signal passed to a device driver can be a virtual standard color. For this reason, the application side does not need to perform color matching, and the device driver itself performs it. The device driver manages color matching informations by saving them as color files of ink makers. The files can be changed over so that reference to the color samples in the same environment can be made from any application. In case of Macintosh, the device driver has cdev resources. This mechanism enables color correction from the Control Panel while operating an application, further, once-set values become common values to all the applications.

When using the device-independent color processing method according to the present invention, an application and a device driver can communicate with each other. In this case, the setting values of the device driver can be directly controlled from the application. Fig. 15 shows the relation between the direct control from the application. In Fig. 15, reference numeral 3 denotes a computer; 60, a printer; 61, a device driver for controlling the printer 60, which always exists in the computer 3; 62, a correction data file for a specific set of electronic color codes; and 63, a correction data file for a second set of electronic color codes. The device driver 61 directly uses the respective correction files, however, the application can indirectly use them, as shown in Fig. 15. Further, the correction files can be controlled from the cdev.

As described above, the device-independent color processing method enables color processing based on the standard color space to image data received from an input device, since the data is conceptually transmitted in accordance with virtual standard color space. Further, in this method, image data can be transmitted to an output device without color processing operation. Accordingly, a color processing system which improves the operation speed without accumulative errors such as rounding error, and optimizes hardware resource with maintaining the device-independent concept can be realized.

As described above, according to the present invention, a plurality of devices having different color space can be utilized as one virtual device.

The present invention can be applied to a system constituted by a plurality of devices, or to an apparatus comprising a simple device. Furthermore, it goes without saying that the invention is applicable also to a case where the object of the invention is attained by supplying a program to a system or apparatus.

The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention. Therefore, to apprise the public of the scope of the present invention, the following claims are made.

Claims

1. A color processing method for a computer system having a plurality of device drivers respectively for image input/output devices and a plurality of color correction means for the input/output devices corresponding to the respective device drivers, the computer system processes color image data, comprising the steps of:

   performing color correction of the input/output devices by instructing the respective device drivers; and

   holding the color-corrected data by the respective device drivers.

2. The method according to claim 1, wherein the respective device drivers hold the color-corrected data as a correction data file with respect to a set of electronic color codes.

3. A color processing method for a system which transmits color image data from a first device to a second device, comprising the steps of:

   inquiring the second device from the first device of color space and presence/absence of color space conversion function;

   if the second device has the color space conversion function, transmitting the color image data with a parameter for converting the data into data of the color space of the second device; and

   if the second device does not have the color space conversion function, converting the color image data to data of the color space of the second device and transmitting the converted color image data to the second device.

4. The system according to claim 3, wherein the color space is a three primary color representation as a color mixing system such as RGB, XYZ, CMY and YIQ.

5. The system according to claim 3, wherein the inquiry in the inquiring step is performed by packet transmission in a Virtual Color Space Conversion Protocol.

6. A color processing method for a system which transmits color image data from a first device to a second device, comprising the steps of:

   inquiring the second device from the first device of color space and presence/absence of color space conversion function;

   if the second device has the color space conversion function, transmitting the color image data with a first parameter for converting the color image data to data of a standard color space between both devices;

   converting the color image data received from the first device to data of color space of the second device using a third parameter obtained from operation of a second parameter for conversion from the standard color space to the color space of the second device and the first parameter; and

   if the second device does not have the color space conversion function, converting the color image data into data of the color space of the second device and transmitting the converted color image data to the second device.

7. The method according to claim 6, wherein the color space is three primary color representation as a color mixing system such as RGB, XYZ, CMY and YIQ.

8. The method according to claim 6, wherein the inquiry in the inquiring step is performed by packet transmission in a Virtual Color Space Conversion Protocol.

9. The method according to claim 6, wherein the standard color space is NTSC RGB.

10. A color processing method for a system which corrects color space of color image data inputted from a first device and outputs the data into a second device, comprising the steps of:

    inputting color image data from the first device;

    operating first parameter for converting color space of the first device into a standard color space and a second parameter for converting the standard color space to color space of the second device;

    correcting color space of the color image data based on the operation result; and

    outputting the color image data of the corrected color space into the second device.

11. The method according to claim 10, wherein the color space is three primary color representation as a color mixing system such as RGB, XYZ, CMY and YIQ.

12. The method according to claim 10, wherein the standard color space is NTSC RGB.

13. The method according to claim 10, wherein the first device is a scanner, and the second device is a printer.

14. A method of transmitting image data wherein the data are transmitted either in an original colour space with information defining said colour space, or in a translated colour space automatically, according to whether a receiving apparatus includes means for colour space conversion.

15. A computer system including device drivers for colour image processing peripherals, wherein communication of image data between an application process and said peripherals employs device-independent colour space definitions, at least as between the application process and each device driver.

FIG. 1

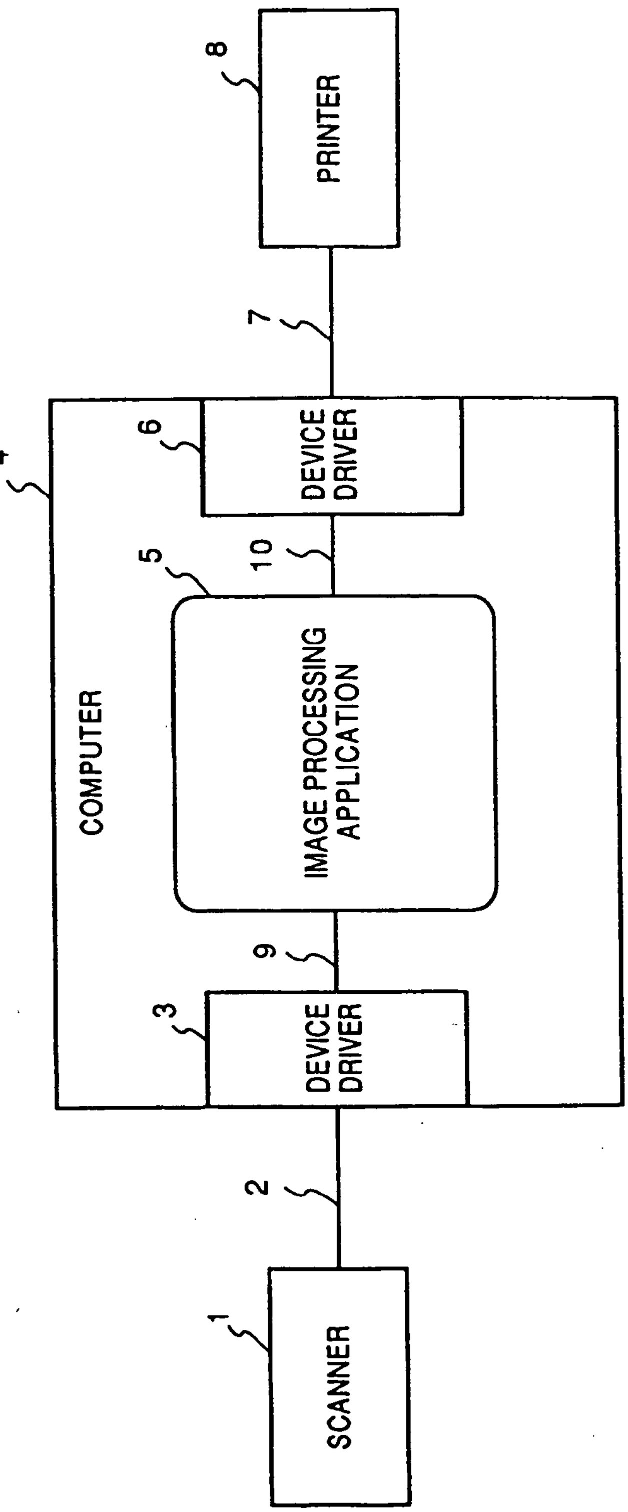

SCANNER
1
2
DEVICE DRIVER
3
9
COMPUTER
4
IMAGE PROCESSING APPLICATION
5
10
DEVICE DRIVER
6
7
PRINTER
8

FIG. 2

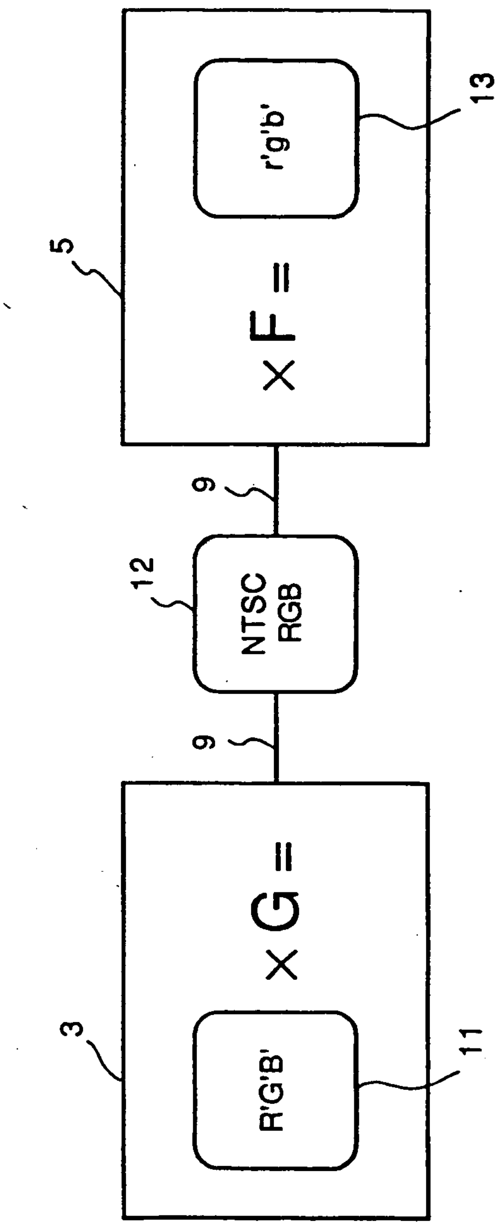


FIG. 3

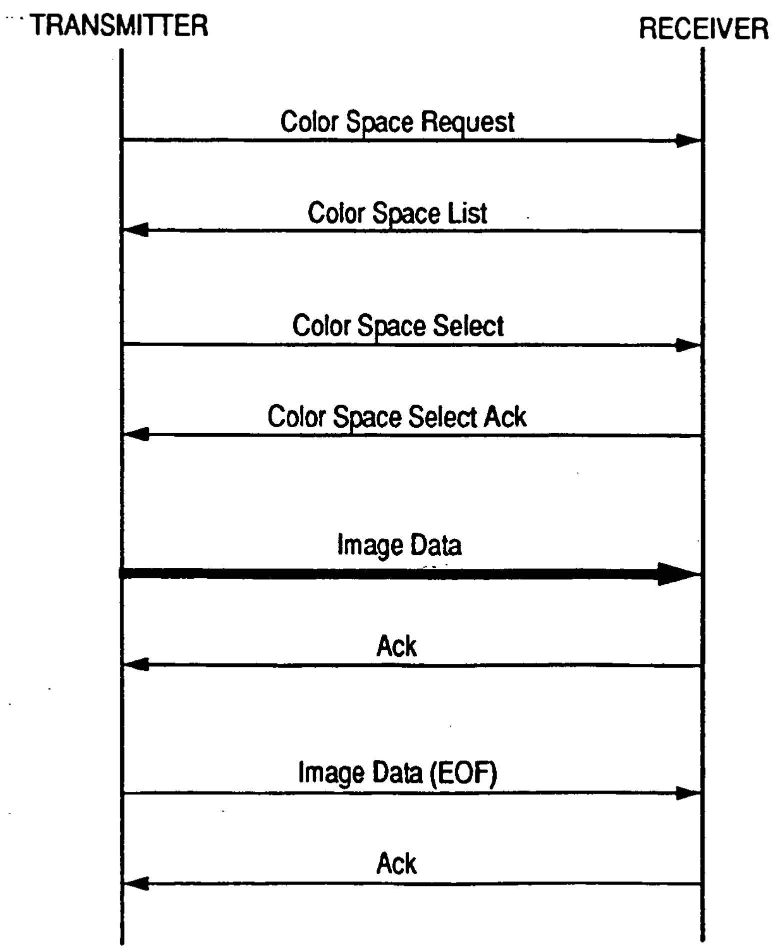

TRANSMITTER
RECEIVER
Color Space Request
Color Space List
Color Space Select
Color Space Select Ack
Image Data
Ack
Image Data (EOF)
Ack

FIG. 4

COLOR SPACE REQUEST PACKET

PACKET ID	COLOR SPACE REQUEST	41
COMMAND ID	COLOR SPACE	42
LENGTH	3	43
CONTENT (COLOR SPACE)	"RGB"	44
COMMAND ID	CAPABILITY	42'
LENGTH	1	43'
CONTENT (CAPABILITY)	NO	44'
TERMINATOR	0	45

FIG. 5

COLOR SPACE LIST PACKET

PACKET ID	COLOR SPACE LIST
COMMAND ID	COLOR SPACE
LENGTH	3
CONTENT (COLOR SPACE)	"RGB"
COMMAND ID	CAPABILITY
LENGTH	1
CONTENT (CAPABILITY)	YES
TERMINATOR	0

FIG. 6

COLOR SPACE SELECT PACKET

PACKET ID	COLOR SPACE SELECT
COMMAND ID	COLOR SPACE
LENGTH	3
CONTENT (COLOR SPACE)	"RGB"
COMMAND ID	COLOR METHOD
LENGTH	1
CONTENT (COLOR METHOD)	WITH FILTER
COMMAND ID	FILTER
LENGTH	9
CONTENT (FILTER)	FILTER COEFFICIENTS
TERMINATOR	0

FIG. 7

COLOR SPACE SELECT Ack PACKET

PACKET ID	CLOLOR SPACE SELECT Ack
COMMAND ID	COLOR SPACE
LENGTH	3
CONTENT (COLOR SPACE)	"RGB"
COMMAND ID	COLOR METHOD
LENGTH	1
CONTENT (COLOR METHOD)	WITH FILTER
TERMINATOR	0

FIG. 8

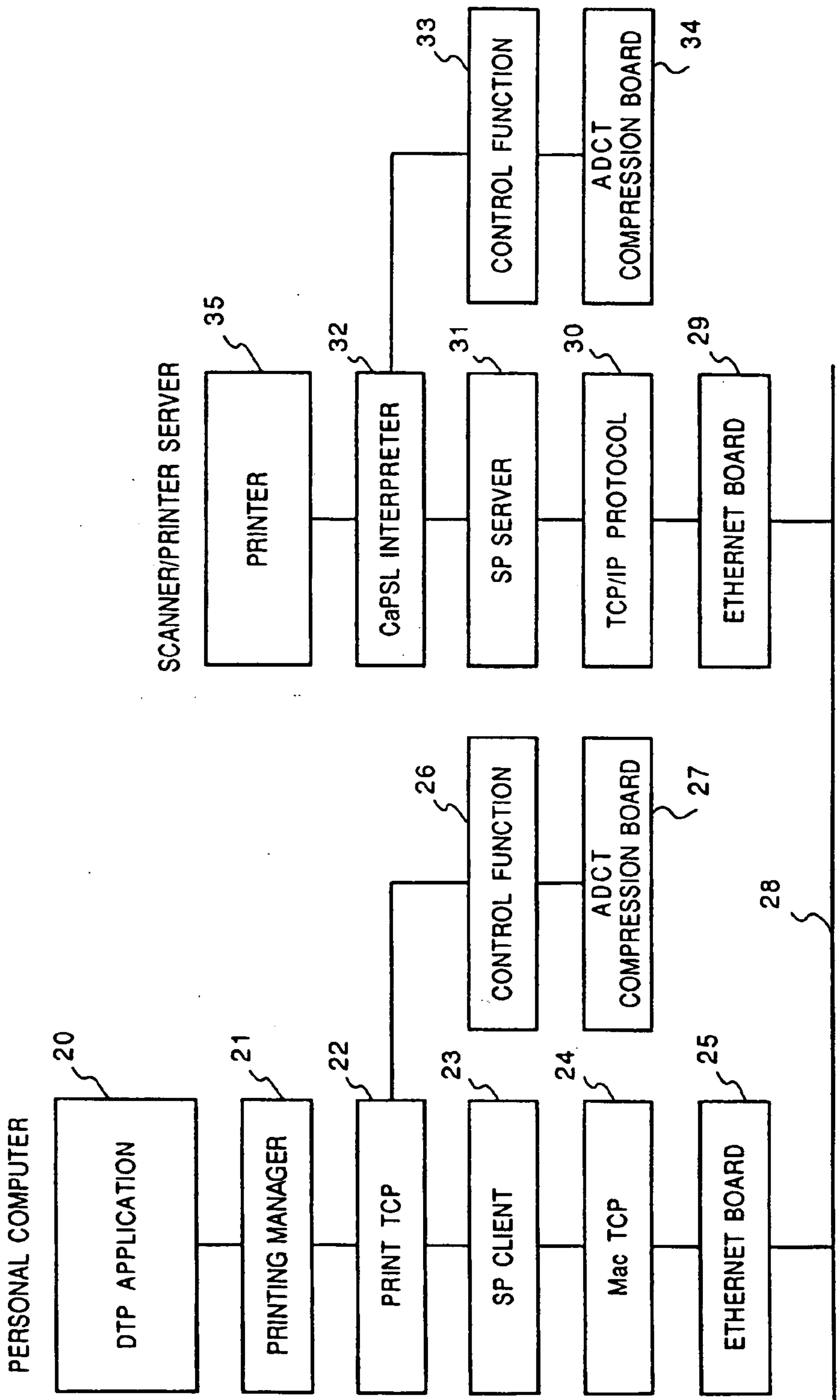

PERSONAL COMPUTER
DTP APPLICATION
PRINTING MANAGER
PRINT TCP
SP CLIENT
Mac TCP
ETHERNET BOARD
CONTROL FUNCTION
ADCT COMPRESSION BOARD
SCANNER/PRINTER SERVER
PRINTER
CaPSL INTERPRETER
SP SERVER
TCP/IP PROTOCOL
ETHERNET BOARD
CONTROL FUNCTION
ADCT COMPRESSION BOARD
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

FIG. 9

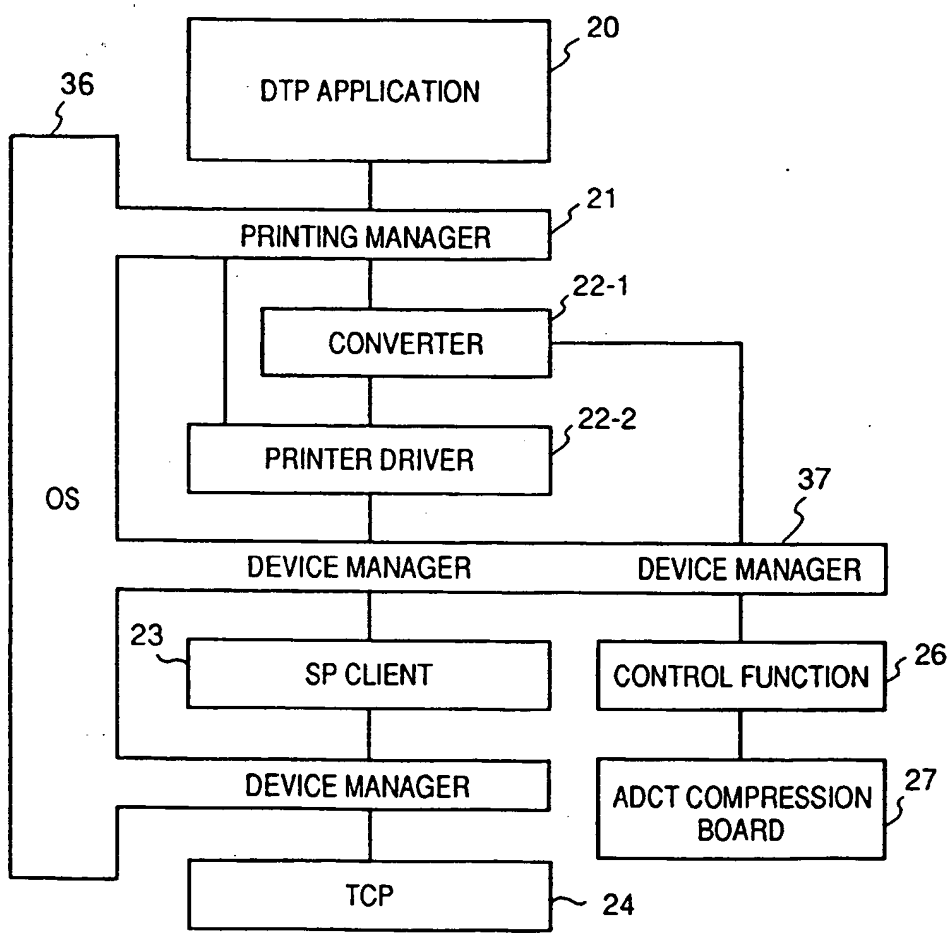

DTP APPLICATION
20
36
PRINTING MANAGER
21
CONVERTER
22-1
PRINTER DRIVER
22-2
OS
37
DEVICE MANAGER
DEVICE MANAGER
23
SP CLIENT
CONTROL FUNCTION
26
DEVICE MANAGER
ADCT COMPRESSION BOARD
27
TCP
24

FIG. 10

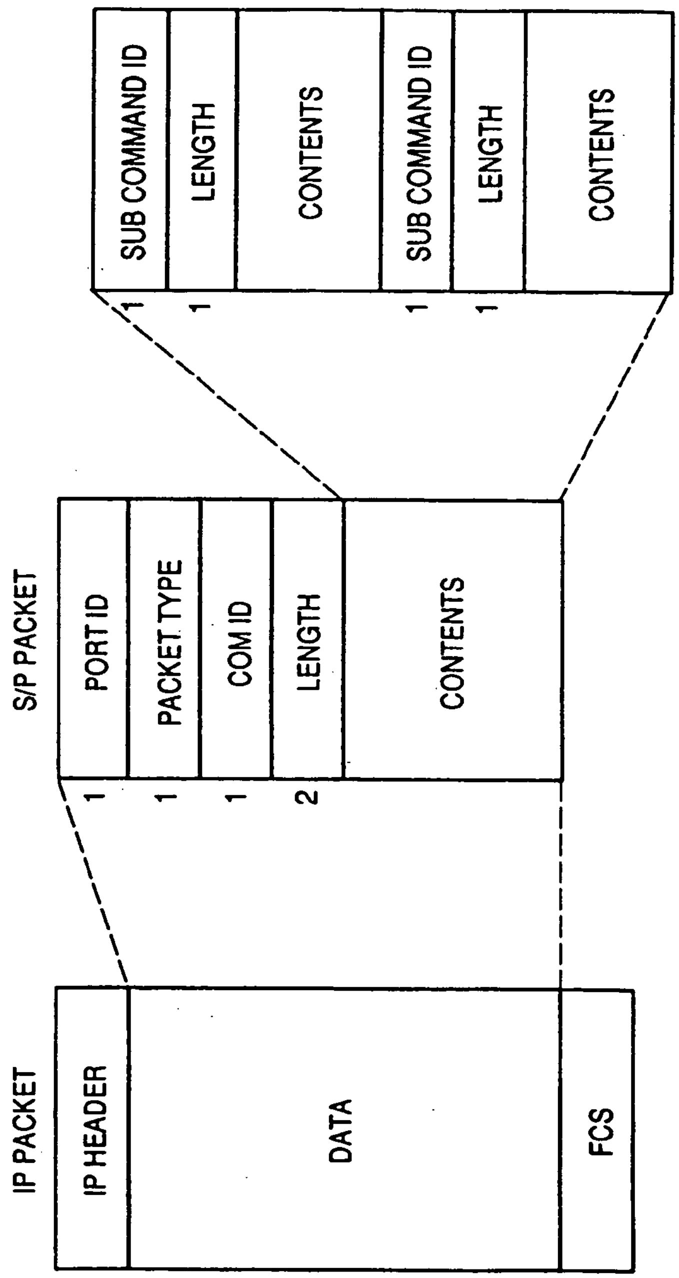

IP PACKET
IP HEADER
DATA
FCS
S/P PACKET
PORT ID
PACKET TYPE
COM ID
LENGTH
CONTENTS
1
1
1
2
SUB COMMAND ID
LENGTH
CONTENTS
SUB COMMAND ID
LENGTH
CONTENTS
1
1
1
1

FIG. 11

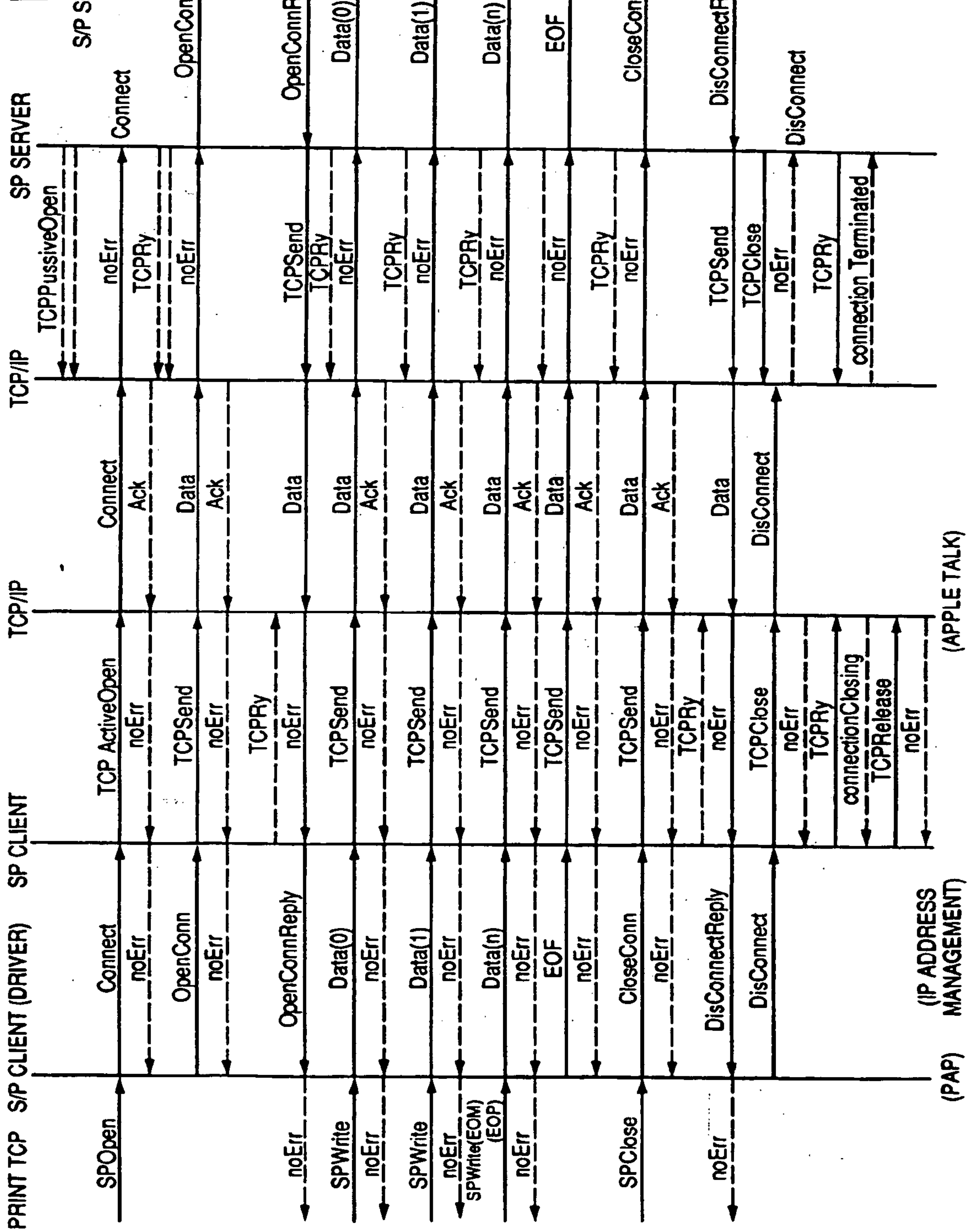

PRINT TCP
S/P CLIENT (DRIVER)
SP CLIENT
TCP/IP
TCP/IP
SP SERVER
S/P SERVER (DRIVERr)CaPSL
SPOpen
noErr
SPWrite
noErr
SPWrite
noErr
SPWrite(EOM) (EOP)
noErr
SPClose
noErr
Connect
noErr
OpenConn
noErr
OpenConnReply
Data(0)
noErr
Data(1)
noErr
Data(n)
noErr
EOF
noErr
CloseConn
noErr
DisConnectReply
DisConnect
TCP ActiveOpen
noErr
TCPSend
noErr
TCPRy
noErr
TCPSend
noErr
TCPSend
noErr
TCPSend
noErr
TCPSend
noErr
TCPSend
noErr
TCPRy
noErr
TCPClose
noErr
TCPRy
connectionClosing
TCPRelease
noErr
Connect
Ack
Data
Ack
Data
Data
Ack
Data
Ack
Data
Ack
Data
Ack
Data
Ack
Data
DisConnect
TCPPussiveOpen
noErr
TCPRy
noErr
TCPSend
TCPRy
noErr
TCPRy
noErr
TCPRy
noErr
noErr
TCPRy
noErr
TCPSend
TCPClose
noErr
TCPRy
connection Terminated
Connect
OpenConn
OpenConnReply
Data(0)
Data(1)
Data(n)
EOF
CloseConn
DisConnectReply
DisConnect
Print
(PAP)
(IP ADDRESS MANAGEMENT)
(APPLE TALK)

FIG. 12

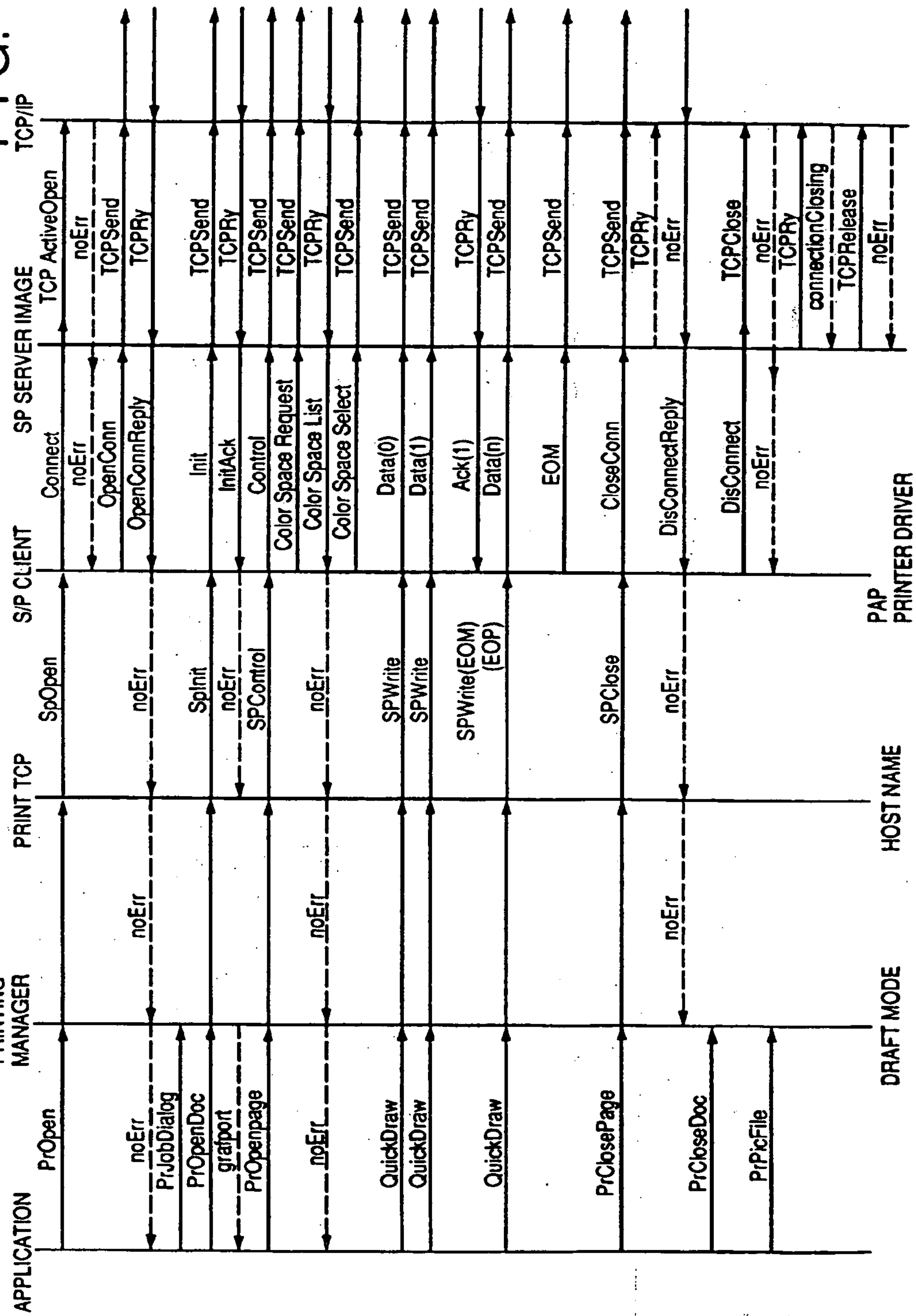

APPLICATION
PRINTING MANAGER
PRINT TCP
S/P CLIENT
SP SERVER IMAGE
TCP/IP
DRAFT MODE
HOST NAME
PAP PRINTER DRIVER
PrOpen
noErr
PrJobDialog
PrOpenDoc
grafport
PrOpenpage
QuickDraw
PrClosePage
PrCloseDoc
PrPicFile
SpOpen
SpInit
SPControl
SPWrite
SPWrite(EOM) (EOP)
SPClose
Connect
OpenConn
OpenConnReply
Init
InitAck
Control
Color Space Request
Color Space List
Color Space Select
Data(0)
Data(1)
Ack(1)
Data(n)
EOM
CloseConn
DisConnectReply
DisConnect
TCP ActiveOpen
TCPSend
TCPRy
TCPClose
connectionClosing
TCPRelease

FIG. 13

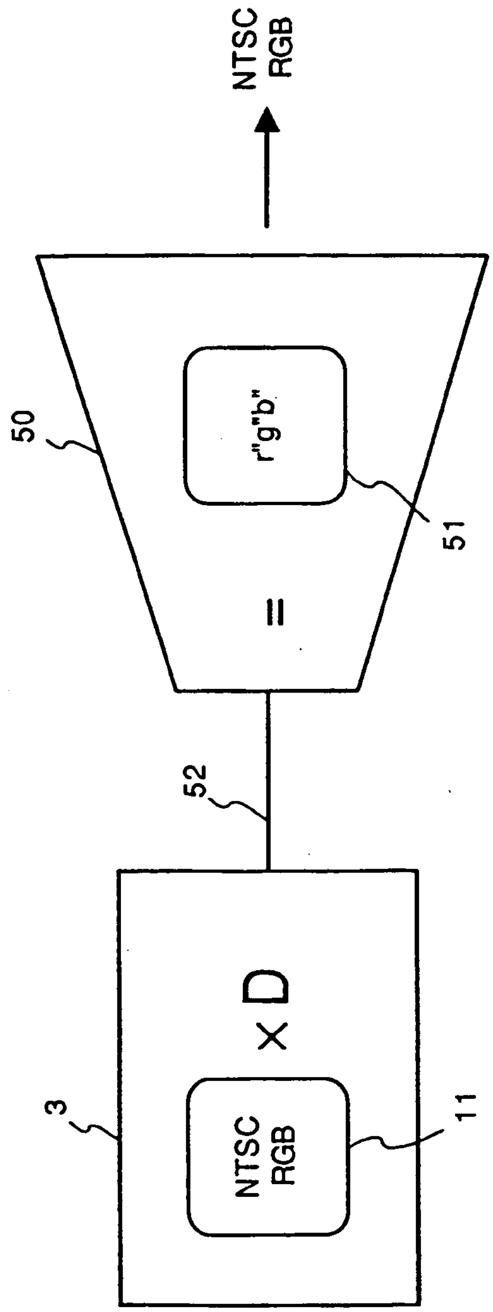


FIG. 14

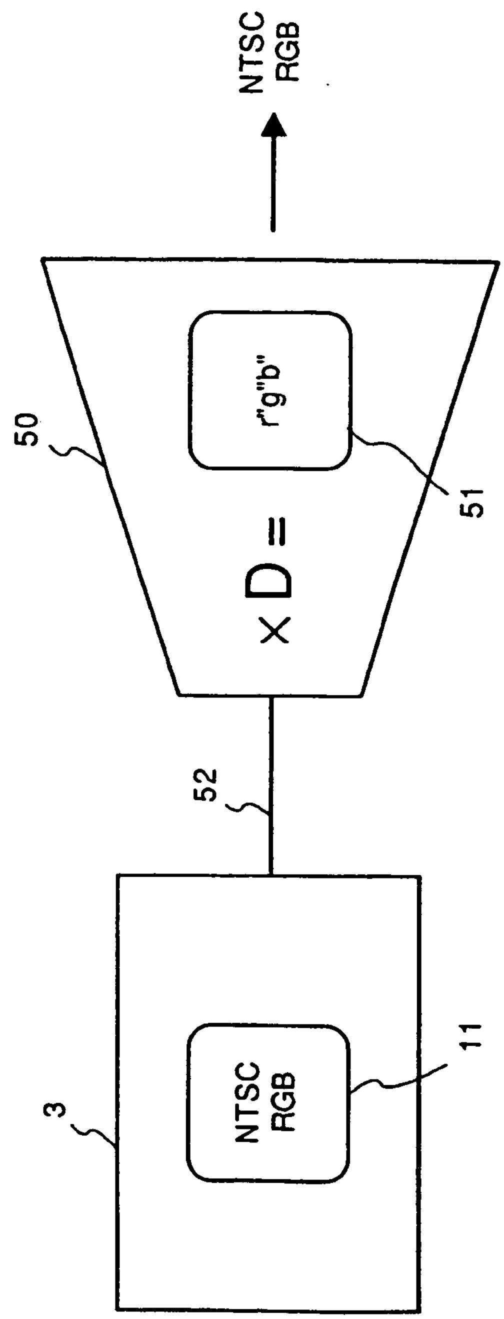
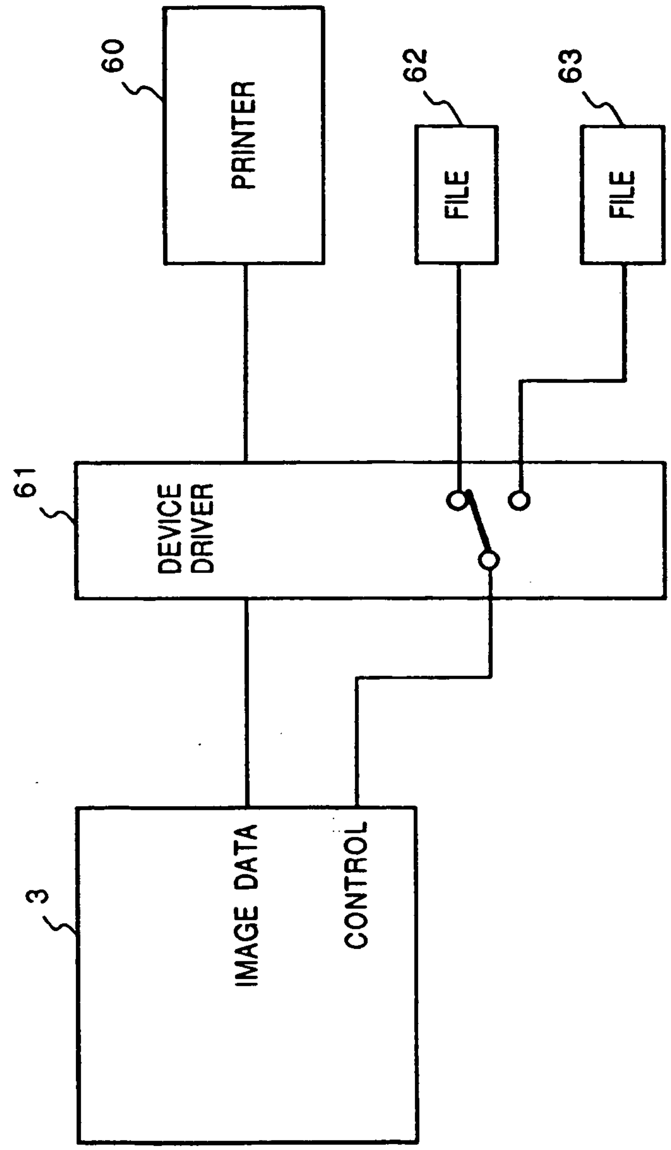


FIG. 15


60
PRINTER
62
FILE
63
FILE
61
DEVICE
DRIVER
3
IMAGE DATA
CONTROL

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

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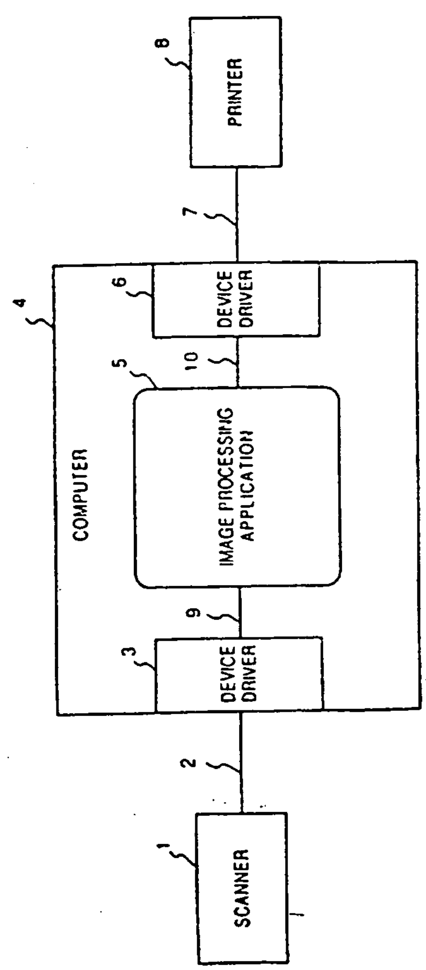
(54) **Color processing method.**

(57) A color processing method utilizing a plurality of devices having different color spaces as one virtual device. A scanner inquires a computer of color space and presence/absence of a color conversion function. If the computer has the color space conversion function, the scanner transmits color image data with parameters for converting the data into data of the color space of the computer. Inversely, the computer inquires the printer of color space and presence/absence of a color space conversion function. If the printer has the color space conversion function, the computer transmits color image data with parameters obtained from operation of parameters for converting the color space of the image data into the color space of the printer and the parameters received from the scanner.

FIG. 1



EP 0 581 590 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 5987

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y	DE-A-34 08 321 (CANON K.K.) * page 8, line 28 - line 32 * * page 10, paragraph 2 * * page 13, line 19 - line 30 * * page 26, line 5 - line 7 * ---	1,2 3,6,10, 13	G06F3/033 H04N1/46
Y	US-A-4 897 799 (D. J. LE GALL ET AL) * the whole document * ---	3,6,10, 13	
A	DE-A-40 34 540 (CANON K.K.) ---		
A	GB-A-2 242 290 (ADPLATES) ---		
A	Proceedings, The sixth international congress on advances in non-impact printing technologies, 21-26 October 1990, Orlando, Florida (US), The Society for Imaging Science and Technology, Springfield, VA (US) pages 837-843 T. YAMASAKI: "Optimum color space for color data exchange and its mutual transformation to other color spaces" -----		TECHNICAL FIELDS SEARCHED (Int.Cl.5) H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 July 1994	De Roeck, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 616 200 A1**

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(22) Date of filing: **17.03.94**

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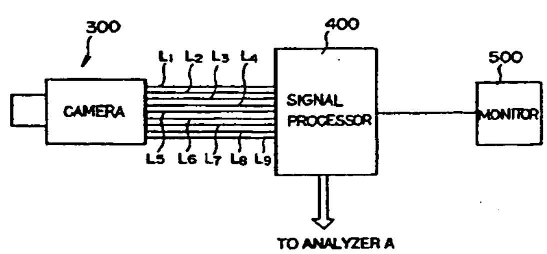
(54) **Camera, spectrum analysis system, and combustion evaluation apparatus employing them.**

(57) A spectrum analysis camera (300) which can, by itself, deliver both an ordinary color picture and a picture for spectrum analysis and a spectrum analysis system. In the CCD (charge-coupled device) section of the camera (300); one photosensitive unit is constituted by n (at least two) photosensors (S_1-S_9). The n photosensors (S_1-S_9) are set so as to have detection wavelength ranges which do not overlap each other. The spectrum analysis is performed using the output signals of the individual photosensors (S_1-S_9) in Fig. 3(b). On the other hand, the color picture is formed using R (red); G (green) and B (blue) signals which are created by synthesizing the output signals of the respective photosensors (S_1-S_9).

FIG. 1



EP 0 616 200 A1

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a camera which can deliver both an ordinary color picture and spectrum analyzing data, a spectrum analysis system, and a combustion evaluation apparatus which employs them.

2. DESCRIPTION OF THE RELATED ART

In a case where a camera employing a CCD (charge-coupled device) or the like is applied to spectrum analysis, only light of a desired wavelength is measured by externally mounting a filter on the camera. Besides, in the case of analyzing a spectrum over a plurality of wavelengths, or in case of requiring an ordinary color picture, a plurality of filters and cameras are used.

Mentioned as an example in which the camera is actually used for the spectrum analysis in this manner is a video system for analyzing the spectrum of flames in a gas turbine combustor as disclosed in Japanese Patent Application Laid-open No. 207912/1991.

The prior art, however, is problematic as stated below. In the case of changing-over the plurality of filters in use, a mechanism for driving the filters is necessitated which incurs the problem of a complicated structure.

It is also considered to install separate cameras for the respective filters. In this case, however, the operations of determining positions and angles for photographing, focusing the cameras, etc. must be performed in correspondence with the number of cameras for use. This poses the problem that a rapid measurement is impossible. Especially in the spectrum analysis, all the cameras need to be focused on an identical location, resulting in very difficult handling.

Another problem is that the system becomes costly.

SUMMARY OF THE INVENTION

The present invention has for its object to provide a camera which can, by itself, deliver an ordinary color picture and simultaneously deliver information for spectrum analysis, and a spectrum analysis system which employs the camera.

Another object of the present invention is to provide a combustion evaluation apparatus which employs the camera and the spectrum analysis system specified above.

In the first aspect of performance of the present invention for accomplishing such objects, there is provided a camera comprising a plurality of photosensors which are disposed on an imaging face thereof, and which separatly deliver photodetection signals of each of the photosensors; at least two of the plurality of photosensors in a predetermined combination being set as one photosensitive unit on a condition that the photosensors included in the one photosensitive unit have detection wavelength ranges which do not overlap each other.

Preferably, the photosensors constituting the one photosensitive unit are arranged in adjacency to each other on the imaging face.

It is also preferable that a comprehensive detection wavelength range of all the photosensors constituting the one photosensitive unit covers the whole visible radiation range.

In a camera for observing light of certain specified wavelength, a photosensor which has a maximum detectivity at and near the specified wavelength should preferably be included in each of the photosensitive units.

It is preferable that at least one member selected from the group consisting of emission wavelengths of a CH radical, a C_2 radical and an OH radical is contained as the specified wavelength.

In the second aspect of performance of the present invention, there is provided a spectrum analysis system comprising the camera defined in the first aspect of performance; and separation means for separating only the signals of the desired photosensors from an output signal of the camera.

In the third aspect of performance of the present invention, there is provided a spectrum analysis system comprising the camera defined in the first aspect of performance; and synthesis means for synthesizing R (red), G (green) and B (blue) signals using an output signal from the camera.

In the fourth aspect of performance of the present invention, there is provided a camera comprising a plurality of photosensors which are disposed on an imaging face thereof, and which separatly deliver photodetection signals of each of the photosensors; the photosensors including at least one member selected from the group consisting of a first photosensor whose detection wavelength range contains an emission wavelength of a CH radical, but does not contain emission wavelengths of either a C_2 radical or an OH radical; a second photosensor whose detection wavelength range contains the emission wavelength of the C_2 radical, but does not contain the emission wavelengths of either the CH radical or the OH radical; and a third photosensor whose detection wavelength range contains the emission wavelength of the OH radical, but does not contain

the emission wavelengths of either the CH radical or the C_2 radical.

In the fifth aspect of performance of the present invention, there is provided a camera comprising a plurality of photosensors which are disposed on an imaging face thereof, and which separately deliver photodetection signals of each of the photosensors; at least two adjacent ones of the plurality of photosensors being set as one photosensitive unit; the one photosensitive unit including at least two members selected from the group consisting of a first photosensor whose detection wavelength range contains an emission wavelength of a CH radical, but does not contain emission wavelengths of either a C_2 radical or an OH radical; a second photosensor whose detection wavelength range contains the emission wavelength of the C_2 radical, but does not contain the emission wavelengths of either the CH radical or the OH radical; and a third photosensor whose detection wavelength range contains the emission wavelength of the OH radical, but does not contain the emission wavelengths of either the CH radical or the C_2 radical.

In the sixth aspect of performance of the present invention, there is provided a spectrum analysis system comprising the camera defined in the fourth aspect of performance; and separation means for separating only the signals of the desired photosensors from an output signal of the camera.

In the seventh aspect of performance of the present invention, there is provided a spectrum analysis system comprising the camera defined in the fourth aspect of performance; and synthesis means for synthesizing R (red), G (green) and B (blue) signals using an output signal from the camera.

In the eighth aspect of performance of the present invention, there is provided a camera comprising a plurality of photosensors, which separately deliver photodetection signals of each of the photosensors; at least two adjacent ones of the plurality of photosensors being set as one photosensitive unit; the one photosensitive unit including photosensors for a color picture which exhibit sensitivity curves agreeing with those of ordinary color television, and photosensors for spectrum analysis whose detection wavelength ranges do not overlap one another.

In the ninth aspect of performance of the present invention, there is provided a spectrum analysis system comprising the camera defined in the eighth aspect of performance; and separation means for separating only the signals of the desired photosensors among the output signals derived from the photosensors for the spectrum analysis.

In the tenth aspect of performance of the present invention, there is provided a combustion evaluation apparatus for evaluating a combustion state of flames, comprising a camera which photographs the flames; display means for displaying a picture of the frames by using an output signal from the camera; and arithmetic means for obtaining a physical quantity for evaluating a combustion property of the flames, using the output signal from the camera.

In the eleventh aspect of performance of the present invention, there is provided a combustion system comprising a burner which burns a mixture consisting of fuel and air; feed means for feeding the fuel and the air to the burner; adjustment means for adjusting a feed rate of at least one of the fuel and the air which are to be fed to the burner; a camera which photographs flames; display means for displaying a picture of the frames by using an output signal from the camera; arithmetic means for obtaining a physical quantity for evaluating a combustion property of the flames, by using the output signal from the camera; and control means for controlling the adjustment means in accordance with the physical quantity obtained by the arithmetic means.

The first thru third aspects of performance correspond to Claims 1 thru 7, and will be explained below from operational viewpoints.

The output signals of the respective photosensors are separated by the separation means, whereby the intensities of light components in the certain detection wavelength ranges can be detected. On the other hand, the output signals of the respective photosensors are synthesized by the synthesis means, whereby the ordinary color picture can be obtained.

In the case of an application to the evaluation of the combustion state of flames, the emission intensity of the radical of an intermediate reaction product attendant upon combustion can be detected by setting at least one of 310 [nm], 431 [nm] and 517 (nm] as the specified wavelength.

The fourth thru seventh aspects of performance corresponding to Claims 8 thru 11 will be explained.

The first thru third photosensors each detect only the emissions of the specified radicals, and they do not detect the emission of any other radical. Accordingly, when the photosensors of at least one of the three sorts are included, the combustion state of flames can be determined. Further, when the photosensors of at least two of the three sorts are included, the photodetection signals of the camera can be used for such processing as taking the ratio between both the signals.

The eighth and ninth aspects of performance corresponding to Claims 12 and 13 will be ex-

plained.

The ordinary color picture can be obtained by using the output signals from the photosensors for the color picture. On the other hand, information items in the desired detection wavelength ranges can be obtained in such a way that the output signals of the photosensors for the spectrum analysis are separated by the separation means.

The tenth and eleventh aspects of performance corresponding to Claims 14 thru 16 will be explained.

It is permitted to monitor the combustion state on the basis of the picture of the flames displayed on the display means and to evaluate the combustion state by using the physical quantity calculated by the arithmetic means. Further, the control means controls the adjustment means by using the physical quantity. Thus, the feed rate/rates of the fuel and/or the air based on the feed means can be precisely adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the general construction of a spectrum analysis system according to the present invention;

Fig. 2 is a schematic diagram showing photosensors which constitute one photosensitive unit in the CCD (charge-coupled device) section of a camera according to the present invention;

Figs. 3(a) thru 3(c) are graphs for explaining the relative detectivities of the camera of the present invention and a conventional camera;

Fig. 4 is a graph showing the ideal relative detectivity of the camera in the case where the camera of the present invention is made versatile;

Fig. 5 is a graph showing an example of the relative detectivity of the camera in the case where photosensors for a color picture and photosensors for spectrum analysis are disposed completely separately;

Fig. 6 is a graph showing another example of the relative detectivity of the camera in the case where photosensors for a color picture and photosensors for a spectrum analysis are disposed completely separately;

Figs. 7(a) and 7(b) are graphical illustrations showing an example of the relative detectivity of the camera in the case where the detection wavelength ranges of photosensors are changed;

Fig. 8(a) is a graphical illustration showing a situation in the case where the spectrometric camera of the present invention is applied to a combustion system;

Fig. 8(b) is agraphical illustration showing a relationship between emission intensity ratio and air ratio.

Fig. 9 is a schematic block diagram showing the general construction of the combustion system in an embodiment of the present invention;

Fig. 10 is an explanatory diagram showing a light receiving system;

Fig. 11 is a graph showing the relative detectivity of the camera in the embodiment;

Fig. 12 is a graph showing the emission spectrum of flames;

Fig. 13 is a graph showing the relationships of emission intensity ratios and air ratios among radicals;

Figs. 14(a), 14(b) and 14(c) are diagrams for explaining a method of obtaining an air ratio distribution picture;

Fig. 15 is a side view, partly in section, showing the combustion system in another embodiment of the present invention;

Fig. 16 is a diagram showing a monitor screen on which a picture taken for the example of Fig. 15 is displayed;

Fig. 17 is a diagram for explaining an example in which the detectivity characteristics of photosensors are changed for the respective regions of an imaging face in accordance with an object to-be-measured; and

Figs. 18(a) and 18(b) are graphical illustrations exemplifying relative detectivity characteristics in the case of Fig. 17.

PREFERRED EMBODIMENTS OF THE INVENTION

A spectrum analysis system embodying the present invention will be described.

The spectrum analysis system in this embodiment features that a single camera can be used for observing the light component(s) of desired wavelength(s) and simultaneously for obtaining an ordinary color picture.

As illustrated in Fig. 1, the spectrum analysis system is constructed having a camera 300, a signal processor 400 and a monitor 500.

The CCD (charge-coupled device) photosensor section of the camera 300 is shown on an enlarged scale in Fig. 2. The camera 300 has one photosensitive unit constituted by nine photosensors $S_1 \sim S_9$. As illustrated in Fig. 3(b), the detection wavelength ranges of the respective photosensors $S_1 \sim S_9$ do not overlap one another almost completely. On the other hand, in a case where the detection wavelength ranges of the nine photosensors $S_1 \sim S_9$ are collectively viewed, they cover substantially the whole visible radiation region. For comparison's sake, the outlines of the relative de-

tectivity (or detection sensitivity) curves of a conventional camera are illustrated in Fig. 3(c). As seen by comparing the graphs of Figs. 3(b) and 3-(c), the detection wavelength ranges of the photosensors S_1 ~ S_3 lie near the detection wavelength range of a photosensor for blue light (B) in the conventional camera. In addition, the detection wavelength ranges of the photosensors S_4 ~ S_6 lie near the detection wavelength range of a photosensor for green light (G) in the conventional camera. Besides, the detection wavelength ranges of the photosensors S_7 ~ S_9 lie near the detection wavelength range of a photosensor for red light (R) in the conventional camera. The adjustments of such detection wavelength ranges can be made by altering the light transmission characteristics of a filter/filters which is/are disposed in the photosensor section. The light transmission characteristics can be altered by, for example, forming the plurality of stacked filters of the different characteristics or setting unequal film thicknesses or different compositions for the individual domains of the single filter.

Referring back to Fig. 1, the camera 300 is furnished with output signal lines L_1 ~ L_9 which are provided in correspondence with the respective photosensors S_1 ~ S_9. Thus, the detection signals of the respective photosensors S_1 ~ S_9 can be delivered to the signal processor 400 independently of one another and every photosensitive unit. Needless to say, however, even when the output signal lines themselves are not independently led to the signal processor 400 in the number of nine, the signal components of the respective photosensors may be output in a separable state. Since the arrangements of circuits etc. for realizing such independent outputs are not, per se, especially restricted, they shall be omitted from description here.

The signal processor 400 has such functions as synthesizing the output signals from the respective photosensors S_1 ~ S_9 and arithmetically processing them as required. Also, this processor 400 has the function of supplying the monitor 500 or any other analyzer A with the output signals of the camera 300 directly or after the synthesis or arithmetic processing thereof. By the way, "separation means" and "synthesis means" mentioned in the appended claims are implemented by the signal processor 400.

The monitor 500 is an ordinary color monitor (or monochromatic monitor).

Next, let's consider a case where light having a spectral distribution shown in Fig. 3(a) is observed by the use of the spectrum analysis system.

A light component of wavelength λ_1 is detected only by the photosensor S_1. Besides, a light component of wavelength λ_2 is detected only by the photosensor S_2. Likewise, light components of wavelengths λ_4, λ_5 and λ_7 are respectively detected only by the photosensors S_4, S_5 and S_7. The signal processor 400 supplies the analyzer A with only the signals of the photosensors for detecting the light components to-be-analyzed. By way of example, in the case of analyzing the light components of the wavelengths λ_1 and λ_7, the signal processor 400 delivers the detection signals of the photosensors S_1 and S_7. Of course, also in this case, the detection signal of the photosensor S_1 and that of the photosensor S_7 are sent in the state in which they can be subjected to separation etc.

The analyzer A obtains information on the light components of the desired wavelengths by analyzing the signals sent from the signal processor 400. Incidentally, the analisis method is not restricted in any way. In this case, strictly speaking, the emergent position of the light component detected by the photosensor S_1 is different from that of the light component detected by the photosensor S_7. Since, however, all the photosensors S_1 ~ S_9 are existent in close proximity, the signals detected by the respective photosensors may usually be handled as corresponding to the light components which have emerged from an identical position.

On the other hand, the signal processor 400 executes the synthesis etc. of the output signals for the monitor 500 in parallel with the delivery of the output signals to the analyzer A. The synthesis serves to obtain the ordinary color picture. More specifically, the signal processor 400 synthesizes all the signals of the photosensors S_1 ~ S_3 and delivers the synthesized signal corresponding to a B (blue) signal produced by the conventional camera. Also, it synthesizes the signals of the photosensors S_4 ~ S_6 and delivers the synthesized signal corresponding to a G (green) signal produced by the conventional camera. Likewise, it synthesizes the signals of the photosensors S_7 ~ S_9 and delivers the synthesized signal corresponding to an R (red) signal produced by the conventional camera. It is needless to say that, on this occasion, a picture of more natural colors can be obtained by giving weights to the signals of the respective photosensors in the synthesis. Further, a more natural color picture can be obtained in such a way that, in synthesizing the signals which correspond to the G signal by way of example, not only the signals of the photosensors S_4 ~ S_6, but also those of the photosensors S_2, S_3, S_7 and S_8 for the peripheral wavelength regions of the detectivity ranges of the photosensors S_4 ~ S_6 are taken into consideration.

The maximum sensitivities of all the photosensors S_1 ~ S_9 should preferably be equal. However, even when the maximum sensitivities are unequal,

they can be corrected by signal processing. The overlaps of the detection wavelength ranges of the photosensors $S_1 \sim S_9$ should preferably be as small as possible in order to facilitate the synthesis processing and to analyze the spectrum more accurately.

It is preferable for rendering the spectrum analysis system more versatile that the camera 300 has a detectivity curve as shown in Fig. 4, in which the detectivities or detection sensitivities of all the photosensors are flat and in which the valleys of the sensitivities between the respectively adjacent photosensors (parts where the sensitivities are low) are null. The reason therefor is that, in a case where the wavelength of the light component to be analyzed lies at the valley of the detectivity, the detectivity for the light component as required for the analysis becomes insufficient, so the spectrum analysis system is, in effect, inapplicable. On the other hand, for constructing a system which is dedicated to a specified use, it is preferable that the curves of the detectivities of the individual photosensors form crests and that the wavelength of the maximum detectivity is held in agreement with the wavelength of the desired light component (refer to Figs. 3(a) and 3(b)). Needless to say, this is intended to detect the desired light component sensitively and to simultaneously minimize the detections of light components irrelevant to the analysis.

In general, narrowing the detection wavelength ranges of the individual photosensors realizes a measurement of higher versatility and higher precision. In this case, one photosensitive unit is constituted by a larger number of photosensors. It is also considered, in principle, to handle the whole frame (namely, the whole imaging face of the camera 300) as one photosensitive unit under the condition that the detection wavelength ranges of any photosensors do not overlap. Since, in general, a CCD (charge-coupled device) includes several hundred thousand photosensors, the detection wavelength range of each of the photosensors becomes very narrow. Accordingly, it is also possible to perform spectrum analysis at a wavelength resolution which is equivalent to that of a spectroscope employing a prism and a diffraction grating. The camera thus constructed can be regarded as a camera in which a prism is included. In this case, a mechanical driver is not needed for the spectral separation of light as is in the case of the prism, and the whole wavelength range can be measured at the same time. Therefore, the construction is especially effective from the aspects of a quick measurement, a high shock resistance and a miniaturized equipment. The transmission characteristics of such minute regions can be respectively made different, as stated before by forming photosensor section with the stacked or multilayer filters, or by altering the film thickness or constituent material composition of the single filter for the individual domains thereof.

According to the above embodiment, in obtaining the ordinary color picture, the R, G and B signals are created by synthesizing the signals of the photosensors $S_1 \sim S_9$. However, photosensors dedicated to the color picture may well be disposed without such synthesis. By way of example, as illustrated in Fig. 5, among photosensors $S_{11} \sim S_{19}$ which constitute one photosensitive unit, those S_{11}, S_{12} and S_{13} are respectively endowed with the same detectivity curves as in the conventional camera. The detection wavelength ranges of the other photosensors $S_{14} \sim S_{19}$ are prevented from overlapping one another to the utmost, from the same viewpoint as in Fig. 3(b). Thus, the output signals of the photosensors S_{11}, S_{12} and S_{13} can be respectively handled as the R, G and B signals to obtain a more natural color picture. On the other hand, the signals of the photosensors $S_{14} \sim S_{19}$ are used for the analysis of light. According to this example, the obtainment of the more natural color picture and the accurate measurement of the light are made compatible. Herein, the detection wavelength ranges of the photosensors $S_{11} \sim S_{13}$ of one group overlap those of the other photosensors $S_{14} \sim S_{19}$ of the other group. Needless to say, however, no problem is posed because the signals of both the groups are separately utilized in accordance with the respective purposes (the generation of the color picture, and the spectrum analysis). The structure can be applied to monocolor camera or monocoler image.

Although, in the example of Fig. 5, no valleys of sensitivity are formed over the whole detection wavelength range of the photosensors $S_{14} \sim S_{19}$ for the spectrum analysis, this measure is not always required in such a case where the wavelengths of light to be observed are specified beforehand. Since the photosensors for the spectrum analysis do not have their output signals utilized for the generation of the color picture, they may well be endowed with sensitivities only to necessary wavelength ranges just as photosensors $S'_{14} \sim S'_{19}$ illustrated in Fig. 6.

As thus far described, the spectrum analysis system of this embodiment can offer both the spectral detection of high precision and the obtainment of the ordinary color picture equivalent to vision with the naked eye (or a picture in a desired color tone).

It has been stated in the above that, in general, the measurement becomes more precise as the detection wavelength ranges of the photosensors are made narrower. However, in a case where a light component to be detected has a wide

wavelength range, it does not hold true that the narrower detection wavelength range is better. Besides, the extents or widths of the detection wavelength ranges of the respective photosensors need not be equal. By way of example, in the case of a light component 6000 which has a comparatively extensive range of wavelengths as illustrated in Fig. 7(b), the detection wavelength range of a corresponding photosensor S_{103} as illustrated in Fig. 7(a) may well be set wide in accordance with the extent of the wavelength range to-be-detected. In contrast, regarding a light component 5000 whose wavelength range is hardly extensive, the detection wavelength range of a corresponding photosensor S_{102} may well be narrowed. In this case, however, a color picture of natural colors cannot be obtained by synthesizing the signals of photosensors S_{101} ~ S_{103}. It is therefore favorable to adopt the technique illustrated in Fig. 5 or Fig. 6.

The camera employed in the spectrum analysis system is applicable to all spectrum analyses. By way of example, a camera 10 in an embodiment to be described below (a combustion system in Figs. 9 et seq.) is one form of application of the camera in the foregoing embodiment. Although the camera 10 has one photosensitive unit constituted by three sorts of photosensors like the conventional camera, the respective photosensors thereof have detection wavelength ranges which hardly overlap unlike those of the conventional camera. In addition, wavelengths at which the photosensors exhibit the maximum detectivities (450 [nm] for B and 510 [nm] for G) are respectively brought into substantial agreement with the central wavelengths of light components to-be-measured (the light emission of a CH radical at 431 [nm) and that of a C_2 radical at 517 [nm]) (refer to Fig. 8(a)).

There will now be described the embodiment in which the spectrum analyzing camera of the present invention is applied to the combustion system.

The combustion system will be outlined with reference to Fig. 9.

In the combustion system of this embodiment, a combustor 11 is furnished with a burner 50 which produces flames 100. The light emission picture of the flames 100 formed by the burner 50 is taken by the camera 10. This camera 10 is a so-called "electronic camera coping with R, G and B" which can deliver a red picture signal (R signal), a green picture signal (G signal) and a blue picture signal (B signal) both individually and independently as well as synthetically.

The R, G and B camera signals, i. e., the red picture signal (R signal), green picture signal (G signal) and blue picture signal (B signal) delivered from the camera 10 are synthesized, and the color picture of the flames 100 is delivered for monitoring to a conventional color monitor 40. Accordingly, the image of flames similar to the flames 100 observed by The naked eye is projected on the screen or the color monitor 40. At the same time, the color picture is stored in a picture memory 42 shown in Fig. 10, as an original picture which is not processed yet. It is accordingly possible to play back the picture at some other time.

Besides, the R, G and B camera signals produced by the camera 10 are sent to a picture accepting unit 20 and an arithmetic unit 21 in parallel with the delivery thereof to the color monitor 40, etc. The arithmetic unit 21 executes, e. g., air ratio calculation processing for evaluating a combustion state, by the use of the G and B signals. The air ratio calculation processing will be explained in detail later with reference to Fig. 13.

The signals processed by the arithmetic unit 21 are led to a picture processor 22. As to a physical quantity picture for evaluating, for example, the combustion state, the picture processor 22 executes pseudo color display processing, binarization processing for turning intensities into binary values with respect to any desired intensity, the calculations of areas and positions concerning a binarized picture, edge processing for connecting boundaries by lines, the calculations of the areas of regions enclosed with edges, the calculations of the lengths of the edges, the calculations of the average value and variance of the received light intensities of all pixels included in a measurement region, and so forth. Results obtained as the aforementioned feature quantities in relation to the input physical quantity picture are delivered to a comparison unit 24 and a unit 41 for monitoring a picture processing result.

The monitor unit 41 for the picture processing result displays a result obtained through the pseudo color display processing of the physical quantity picture serving chiefly to evaluate the combustion state, though it may well display the processed result image explained before. Accordingly, the monitor unit 41 and the color monitor 40 project images concerning the identical flames 100, but the display picture of the former 41 becomes different from that of the latter 40 (refer to Fig. 10). Incidentally, a result processed by the picture accepting unit 20, arithmetic unit 21 and picture processor 22 is stored in a processed result memory 27 shown in Fig. 9 and can be utilized at some other time.

In the comparison unit 24, the feature quantity data of actual combustion flames actually received as an input are compared with the feature quantity data of ideal combustion flames stored in the memory 23 beforehand. In a case where the difference between the actual combustion flames and the ideal combustion flames is great, control signals for

bringing both the combustion flames into agreement within any desired limits are respectively delivered to a fuel rate controller 30 and an air rate controller 31. In accordance with the corresponding control signals, the fuel rate controller 30 alters the opening degree of a fuel rate control valve 33 for feeding fuel into the combustor 11, and the air rate controller 31 alters the opening degrees of air rate control valves 35, 36 for feeding air into the combustor 11. By way of example, in a case where there is insufficient air, the air rate controller 31 increases the rate of the air to-be-fed. Thus, the optimum combustion state can be maintained at all times.

This embodiment has the construction for detecting the combustion state (that is, the camera 10, the arithmetic unit 21, etc.), as the most important feature thereof. Accordingly, the ensuing description shall be centered on the featuring point.

The camera 10 in this embodiment is the so-called "electronic camera coping with R, G and B" which can deliver the red picture signal (R signal), the green picture signal (G signal) and the blue picture signal (B signal) both individually and independently as well as synthetically. As illustrated in Fig. 11, the relative detectivity of the camera 10 has the maximum sensitivities at 450 [nm] for blue (B), at 510 [nm] for green (G) and at 600 [nm] for red (R). Accordingly, as understood by superposing the relative detectivity on the light emission spectrum of flames depicted in Fig. 12, a picture obtained as the blue picture signal (B signal) when the flames are photographed by the camera 10 corresponds mainly to the light of the CH radical, and a picture obtained as the green picture signal (G signal) corresponds mainly to the light of the C_2 radical. Each of the detection sensitivities is not very narrow, but somewhat wide. Accordingly, the photosensor for detecting blue by way of example has characteristics adapted to detect, not only the light component of the wavelength 450 [nm], but also light components near this wavelength to some extent. However, those components of the light of the flames which are other than the wavelengths shown in Fig. 11 are feeble and do not pose any problem in the analysis.

Further, when viewed as the whole photosensor section, the camera 10 in this embodiment can detect light over the whole visible radiation region.

Next, there will be explained the principles of that calculation of the air ratio of flames which is executed by the arithmetic unit 21.

The "air ratio" is defined as Q_r/Q_t. Here, the symbol Q_r denotes the quantity of air which has been really or actually fed in order to burn a certain quantity of fuel fed. On the other hand, the symbol Q_t denotes the theoretical quantity of air which is required for the perfect combustion of the certain quantity of fuel fed.

Shown in Fig. 12 are those examples of the light emission spectrum of the flames (100 in Fig. 9) which were measured under different air ratio conditions. In the graph of Fig. 12, the air ratio condition #1 corresponds to a case where the air is excessive, and the air ratio condition #2 a case where the air is insufficient. It is understood from the graph that the intense emission light components of OH, CH and C_2 radicals being intermediate reaction products (OH radical: 310 [nm], CH radical: 431 [nm] and C_2 radical: 517 [nm]) are observed, and that the intensities of the emission light components change in accordance with the air ratio conditions. Accordingly, when the relationship of the air ratio with the emission intensity of each radical is investigated beforehand, the air ratio can be known from the emission intensity of the radical (refere to Fig. 8 (b)).

In this case, the measurement of the emission intensity of only one radical is sometimes incapable of distinguishing a low measured intensity value from the lowering of the emission intensity attributed to the dirt of a window or peep hole for observing the flames. The influence of the dirty window can be canceled by evaluating the ratio between the emission intensities of the respective radicals. Results obtained by investigating the relationships between the ratios of the emission intensities of the respective radicals and the air ratio are illustrated in Fig. 13. As is obvious from the graph of the figure, the air ratio of the flames can be made known by finding the emission intensity ratio. Incidentally, the OH radical emits ultraviolet radiation, which usually attenuates in commercially-available optical components which are made from glass materials other than quartz glass.

It is therefore practical that the light emissions of the CH radical and the C_2 radical lying within the visible radiation region are utilized as light components which are easy to handle, in other words, that the air ratio is evaluated by measuring the intensities of the light components of 431 (nm] and 517 [nm].

In the actual determination of the air ratio, the ratio between the emission intensities of the CH and C_2 radicals can be found by measuring the detection intensity ratio between the blue picture signal (B signal) and the green picture signal (G signal) which are delivered from the camera (10 in Figs. 9 and 10). When the intensity ratio is calculated for every photosensitive unit (that is, between a blue pixel and a green pixel which belong to the identical photosensitive unit (i, j) on the frame of the image or the imaging face of the camera) and over the whole frame (or in a desired region), an air ratio distribution picture can be obtained (refer to Figs. 14(a), 14(b) and 14(c)).

As stated above, according to the combustion system of this embodiment, the single camera can be used for monitoring the flames on the basis of the ordinary color picture and for obtaining the picture indicative of the distribution of the air ratio values. Moreover, the air ratio distribution picture can be obtained in a short time period, and it has a high accuracy. Besides, the system can be operated with ease. It is accordingly possible to provide the combustion system which can control the fuel and air rates more precisely, which is favorable for the protection of the environment and which has a high combustion efficiency. In addition, since the single camera is included, a camera focusing operation is easy.

The camera 10 in this embodiment is directly and extensively usable for measuring the combustion states of flames. In this case, as regards the fuel from which the flames are produced, the camera 10 is applicable to various kinds of liquid fuel and gaseous fuel such as natural gas and heavy oil. The reason therefor is that all of these kinds of fuel contain elements C, H etc. and involve the light emissions of the CH radical etc. in its flame part. However, even when the element C is contained, solid fuel such as coal emits radiant heat besides the radical emission light during its combustion. Therefore, another countermeasures are needed for the camera to be applicable. It is needless to say that the camera 10 can be used for the evaluation of all the other combustion states by altering the sensitivity curves of the photosensors thereof.

Another embodiment will be described.

The combustion system of this embodiment features that the combustion properties of a plurality of burners are evaluated and controlled on the basis of a single camera.

A combustor 61 in the combustion system is illustrated in Fig. 15. By the way, the constituents of this embodiment not shown in the figure (for example, the color monitor 40, the arithmetic unit 21 and the monitor 41) are fundamentally the same as in the preceding embodiment illustrated in Figs. 9 and 10.

The combustor 61 is a gas turbine combustor, which includes a group of inner burners 62 and a group of outer burners 63. Among results observed through an observation window or peep hole 64, an air ratio distribution picture is displayed on the screen of the monitor unit 41, and the whole air ratio distributions of flames zones formed by the group of inner burners 62 and the group of outer burners 63 can be simultaneously measured. Accordingly, this embodiment has the effect that the combustion states of the plurality of burners can be evaluated and managed at the same time. It is desirable that the flames zone 67 formed by the group of burners 62 and the flames zone 68 formed by the group of burners 63 have uniform air ratios as illustrated in Fig. 16, respectively. In some cases, however, the air ratio distribution of at least either of the flames zones 67 and 68 becomes nonuniform for some reason. According to this embodiment, it is possible to identify that fact of the nonuniform air ratio distribution has arisen, and to specify the place of the nonuniform distribution. Herein, it is needless to say that, in evaluating the combustion states of the group of inner burners 62, judgement is passed using the data of a region where the flames zone 67 is projected on the monitor screen (refer to Fig. 16). Likewise, it is needless to say that, in evaluating the combustion states of the group of outer burners 63, judgement is passed in view of only a region where the flames zone 68 is projected on the monitor screen (refer to Fig. 16). Accordingly, the adjustments of a fuel rate and an air rate, etc. can be done in order to eliminate the nonuniformity in the air ratio distribution. On the other hand, in a case where the cause of the nonuniformity concerns the structure of the combustor itself, a portion to be remodeled is revealed. The uniform combustion of the flames leads to an enhanced combustion efficiency, and can decrease the p.p.m. (parts per million) of nitrogen oxides in an exhaust gas. Therefore, the measurement of the air ratio distributions is very effective.

By the way, in such a case where a plurality of objects to be measured are existent and where the wavelengths of the emission light components thereof are different (for example, in a case where fuel of the hydrocarbon series is used for the burners 62 and where fuel containing no hydrocarbon is used for the burners 63), the photosensors may well be endowed with different sensitivity or detectivity characteristics in accordance with the positions of the CCD section on the imaging face of the camera. In this embodiment, as illustrated in Figs. 17, 18(a) and 18(b) by way of example, the sensitivity characteristics of the photosensors $S_{24} \sim S_{29}$ and those $S'_{24} \sim S'_{29}$ which are used for the spectrum analysis are made different between the central region 1100 of the imaging face 1000 for mainly projecting the inner burners 62 and in the peripheral region 1200 thereof for mainly projecting the outer burners 63. Needless to say, the sensitivity characteristics of the photosensorS $S_{24} \sim S_{29}$ of the central region 1100 are suited to observe the light of the inner burners 62. On the other hand, the sensitivity characteristics of the photosensors $S'_{24} \sim S'_{29}$ of the peripheral region 1200 are suited to observe the light of the outer burners 63. The photosensorS $S_{21} \sim S_{23}$ for obtaining the color pictured however, are kept having the same characteristics as those of the conventional camera in both the central region 1100 and the peripheral

region 1200. Thus, a more precise spectrum analysis is realized in spite of the use of a CCD (charge-coupled device) which includes the small number of photosensors. Besides, since the CCD having the small number of photosensors is usually inexpensive, the cost of the apparatus can be curtailed further.

Meanwhile, it is considered to apply the spectrometric camera of the present invention to, for example, a process management in a plasma chemical process. The "plasma chemical process" is a process in which a radical entailing light emission is used for a reaction so as to synthesize a substance, and in which the distributed state of the light emitting radical affects the behaviors of the product greatly. It is accordingly necessary to control the internal pressure of a process chamber, the feed rates of starting materials, etc. while the distributed state of the radical is being normally monitored. In the present situation, however, the intensity distribution of the radical light emission is seldom monitored, and the finished product is merely inspected in most cases. Therefore, rejected behaviors are presently exhibited at a high rate. The reason why the monitoring of the intensity distribution of the radical light emission is hardly done in the present situation, is that an apparatus for the monitoring becomes complicated when the conventional camera is used. More specifically, with the conventional camera, a filter adapted to pass only the light of a specified wavelength region must be arranged in front of a lens. Further, in a case where two or more sorts of radicals are to be monitored or where the ordinary color picture is also to be obtained, it is indispensable to mount a mechanical driver for the changes-over of filters or to employ a plurality of cameras. With the construction in which the drive mechanism or the like is mounted, faults are highly liable to take place, and the handling of the apparatus becomes troublesome. On the other hand, with the construction in which the plurality of cameras are employed, these cameras must catch an identical light emission part at all times, but this is very difficult. Incidentally, the "conventional camera" termed here signifies the camera whose detection wavelength ranges of R, G and B overlap one another and cover the whole visible radiation region as illustrated in Fig. 3(c). The spectrometric camera of the present invention and the spectrum analysis system employing it are applicable without being attended with such problems. Accordingly, the intensity distributions of the radical light emissions can be normally monitored, and the quality of the product can be enhanced.

Although each of the embodiments of the combustion systems has been described as including the separate monitors for the color picture and for the spectrum analysis, a single television monitor may well be used. Even in this case, both the functions can be switched merely by altering the contents of signal processing within the apparatus (or the choices of signals to be delivered to the monitor), and hence, faults are hardly liable to occur. In addition, the system is easy of handling.

Although each of the embodiments has been described on the premise of the camera employing the CCD, it is not restricted to the CCD camera. Needless to say, the present invention is also applicable to any other camera which detects light on the basis of another principle or another method, as long as the camera can be endowed with different detection wavelength ranges at the respective parts (respective pixels) of the imaging face thereof.

The present invention is especially effective as stated below.

In a spectrum analysis system according to the present invention, both the creation of a color picture close to the sight of man and a spectrum analysis based on the extraction of only the light of each specified wavelength can be performed using a single camera. This is advantageous in point of cost. Moreover, since filters etc. mounted outside a camera are not used for separating the light components of the respective wavelengths, the spectrum analysis system undergoes infrequent faults and can be handled similarly to a system employing the conventional camera(s).

When the spectrum analysis system of the present invention is applied to, for example, a combustion evaluation apparatus, both the creation of the color picture and the observation of flames based on air ratios can be performed. Besides, the combustion properties of the flames can be evaluated in spatial relations in a short time through only the simple optical adjustments of focusing. Accordingly, the flames can be correctly diagnosed, and the accuracy of a combustion control is enhanced. Further, a combustion system which is favorable for the protection of environment and which has a high combustion efficiency can be provided by applying the apparatus or method.

Claims

1. A camera comprising a plurality of photosensors (S_1-S_a) which are disposed on an imaging face thereof, and which separately deliver photodetection signals of each of said photosensors (S_1-S_a);
at least two of said plurality of photosensors (S_1-S_a) in a predetermined combination being set as one photosensitive unit on a condition that the photosensors (S_1-S_a) included in said one photosensitive unit have detection

wavelength ranges which do not overlap each other.

2. A camera as defined in claim 1, wherein said photosensors (S_1-S_a) constituting said one photosensitive unit are arranged in adjacency to each other on said imaging face.

3. A camera as defined in claim 1, wherein a comprehensive detection wavelength range of all said photosensors (S_1-S_a) constituting said one photosensitive unit covers the whole visible radiation range.

4. A camera for observing ligth of certain specified wavelength as defined in claim 1, wherein a photosensor (S_1-S_a) which has a maximum detectivity at and near the specified wavelength is included in each of the photosensitive units.

5. A camera as defined in claim 4, wherein at least one member selected from the group consisting of emission wavelengths of a CH radical, a C_2 radical and an OH radical is contained as said specified wavelength.

6. A spectrum analysis system, comprising:
the camera (300) defined in claim 1; and
separation means for separating only the signals of the desired photosensors from an output signal of said camera (300).

7. A spectrum analysis system, comprising:
the camera (300) defined in claim 1; and
synthesis means (400) for synthesizing R (red), G (green) and B (blue) signals by using an output signal from said camera.

8. A camera comprising a plurality of photosensors (S_1-S_a) which are disposed on an imaging face thereof, and which separately deliver photodetection signals of each of the photosensors (S_1-S_a);
said photosensors (S_1-S_a) including at least one member selected from the group consisting of:
a first photosensor whose detection wavelength range contains an emission wavelength of a CH radical, but does not contain emission wavelengths of either a C_2 radical or an OH radical;
a second photosensor whose detection wavelength range contains the emission wavelength of the C_2 radical, but does not contain the emission wavelengths of either the CH radical and the OH radical; and
a third photosensor whose detection wavelength range contains the emission wavelength of the OH radical, but does not contain the emission wavelengths of either the CH radical and the C_2 radical.

9. A camera comprising a plurality of photosensors (S_1-S_a) which are disposed on an imaging face thereof, and which separately deliver photodetection signals of each of said photosensors (S_1-S_a);
at least two adjacent ones of said plurality of photosensors (S_1-S_a) being set as one photosensitive unit;
said one photosensitive unit including at least two members selected from the group consisting of:
a first photosensor whose detection wavelength range contains an emission wavelength of a CH radical, but does not contain emission wavelengths of either a C_2 radical and an OH radical;
a second photosensor whose detection wavelength range contains the emission wavelength of the C_2 radical, but does not contain the emission wavelengths of either the CH radical and the OH radical; and
a third photosensor whose detection wavelength range contains the emission wavelength of the OH radical, but does not contain the emission wavelengths of either the CH radical and the C_2 radical.

10. A spectrum analysis system, comprising:
the camera (300) defined in claim 8; and
separation means (400) for separating only the signals of the desired photosensors from an output signal of said camera (300).

11. A spectrum analysis system, comprising:
the camera (300) defined in claim 8; and
synthesis means (400) for synthesizing R (red), G (green) and B (blue) signals by using an output signal from said camera.

12. A camera comprising a plurality of photosensors, photodetection signals of which are separately delivered;
a plurality of adjacent ones of said plurality of photosensors (S_1-S_a) being set as one photosensitive unit;
said one photosensitive unit including:
photosensors for a picture which exhibit sensitivity curves agreeing with those of cameras for ordinary television; and
photosensors for a spectrum analysis whose detection wavelength ranges do not overlap one another.

13. A spectrum analysis system, comprising: the camera (300) defined in claim 12; and separation means (400) for separating only the signals of the desired photosensors (S_1-S_a) among the output signals derived from said photosensors for said spectrum analysis.

14. A combustion evaluation apparatus for evaluating a combustion state of flames, comprising: a camera (300) which photographs the flames; display means (500) for displaying a picture of the flames by using an output signal from said camera (300); and arithmetic means (21) for obtaining a physical quantity for evaluating a combustion property of said flames, by the use of the output signal of said camera (300).

15. A combustion evaluation apparatus as defined in claim 14, wherein said camera (300) is the camera defined in any one of claims 5, 8 or 9.

16. A combustion system, comprising: a burner (50) which burns a mixture consisting of fuel and air; feed means for feeding the fuel and the air to said burner (50); adjustment means (33, 35, 36) for adjusting a feed rate of at least one of said fuel and said air which are to be fed to said burner; a camera (10) which photographs flames; display means (40, 41) for displaying a picture of the flames by using an output signal from said camera (10); arithmetic means (21) for obtaining a physical quantity for evaluating a combustion property of the flames, by using the output signal from said camera (10); and control means (30, 31) for controlling said adjustment means (33, 35, 36) in accordance with the physical quantity obtained by said arithmetic means (21).

17. A combustion system as defined in claim 16, wherein said camera (10) is the camera defined in any one of claims 5, 8 or 9.

FIG. 1

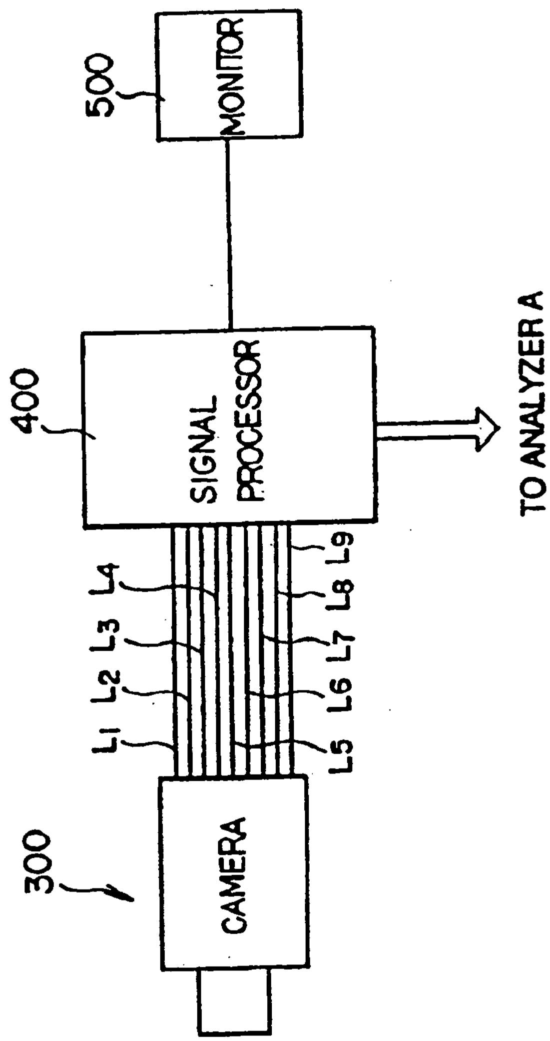
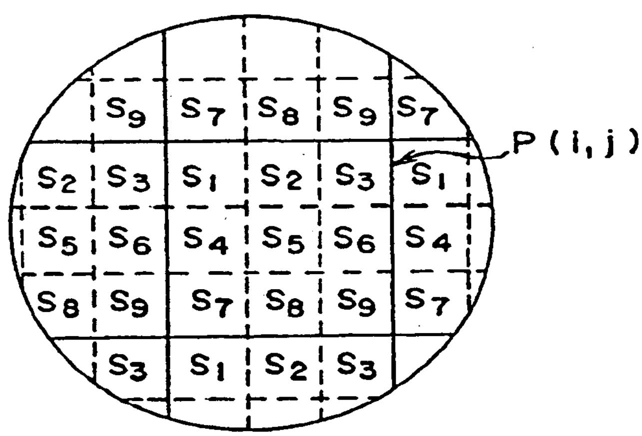

300
CAMERA
L1
L2
L3
L4
L5
L6
L7
L8
L9
400
SIGNAL PROCESSOR
TO ANALYZER A
500
MONITOR

FIG. 2


S9
S7
S8
S9
S7
P (i, j)
S2
S3
S1
S2
S3
S1
S5
S6
S4
S5
S6
S4
S8
S9
S7
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S3
S1
S2
S3

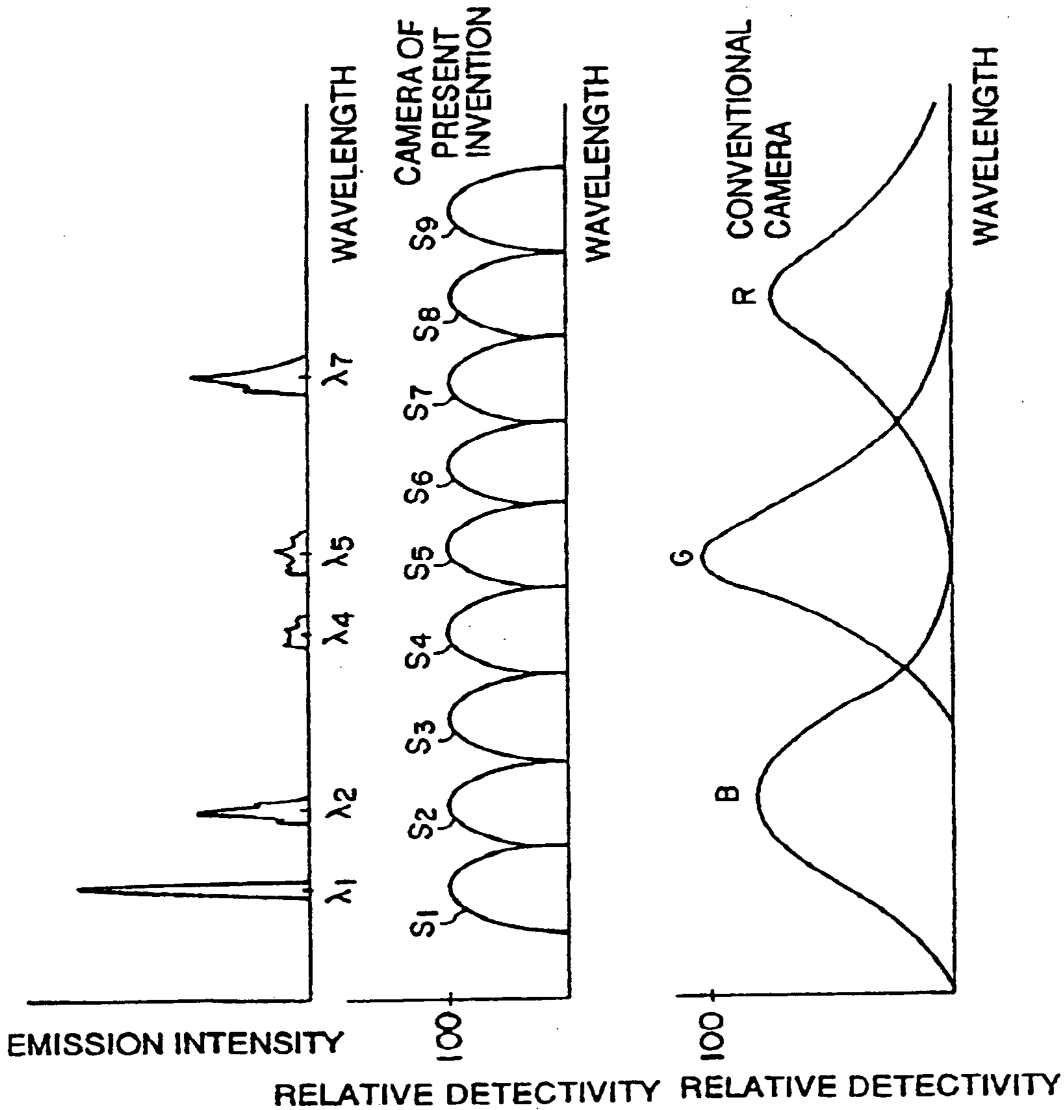


FIG. 3(a)

FIG. 3(b)

FIG. 3(c)
PRIOR ART

FIG. 4

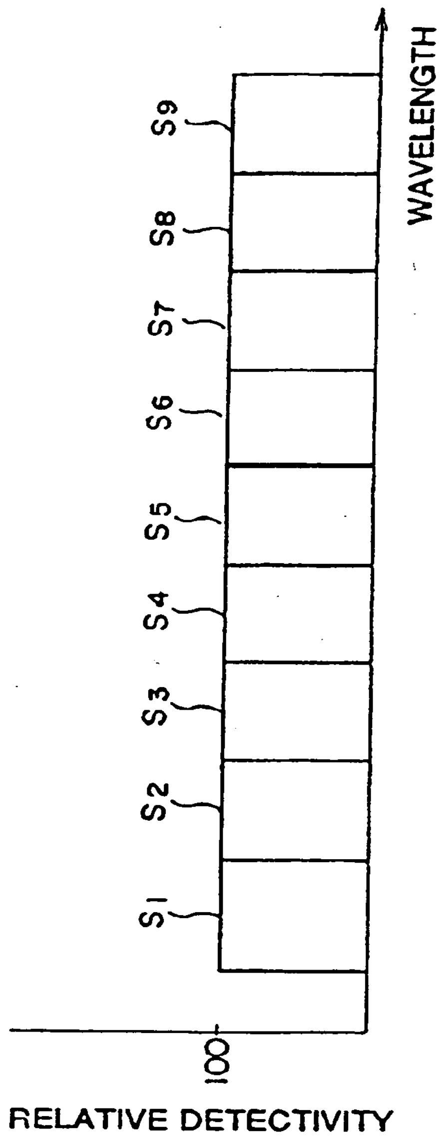

WAVELENGTH
S9
S8
S7
S6
S5
S4
S3
S2
S1
100
RELATIVE DETECTIVITY

FIG. 5

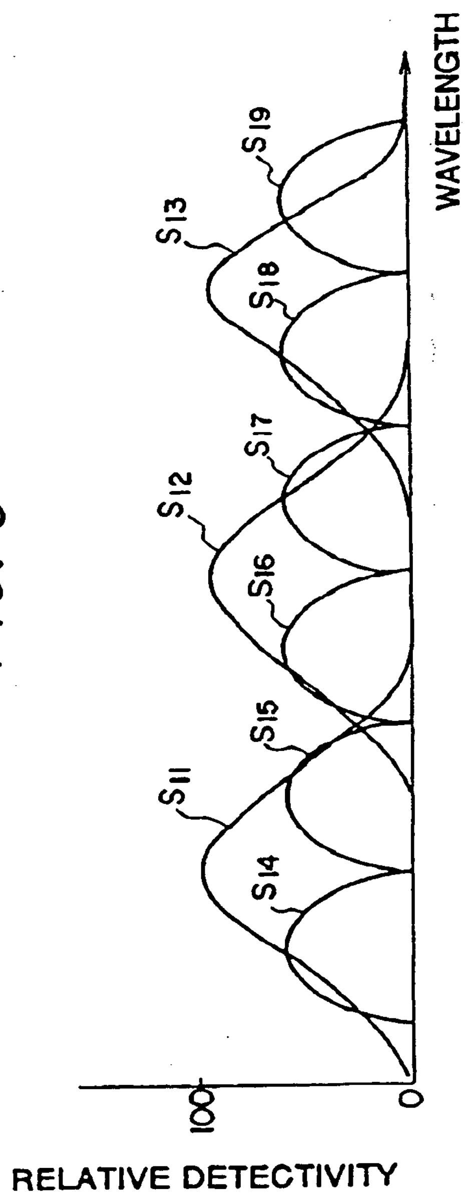

RELATIVE DETECTIVITY
100
0
WAVELENGTH
S11
S12
S13
S14
S15
S16
S17
S18
S19

FIG. 6

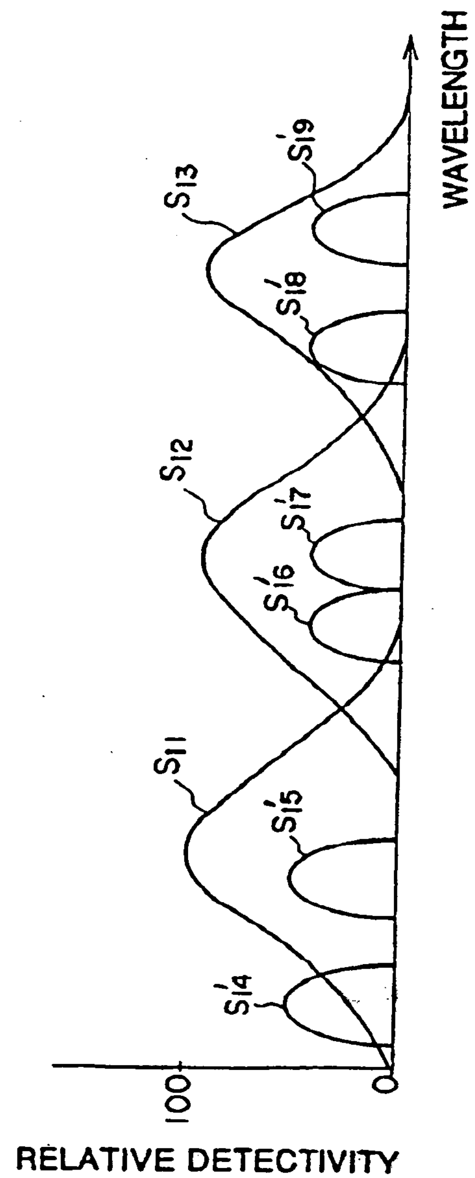

RELATIVE DETECTIVITY
100
0
WAVELENGTH
S11
S12
S13
S'14
S'15
S'16
S'17
S'18
S'19

FIG. 7(b)

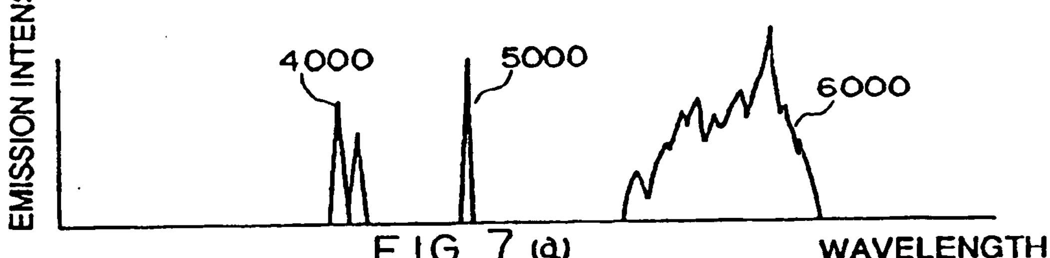

EMISSION INTENSITY
4000
5000
6000
WAVELENGTH

FIG. 7(a)

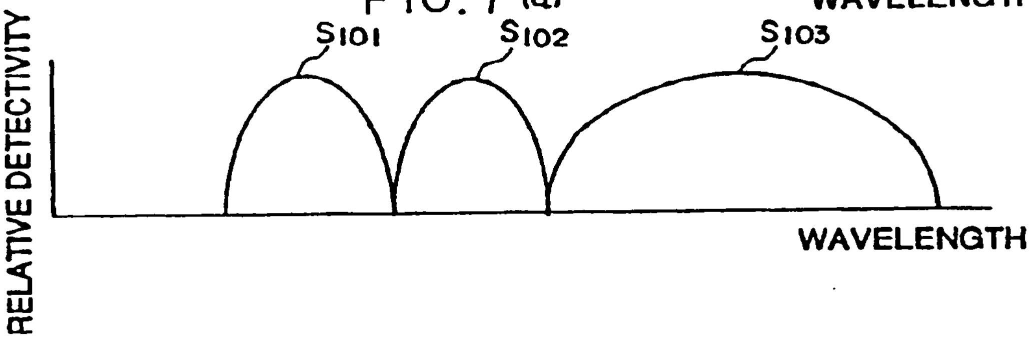

RELATIVE DETECTIVITY
S101
S102
S103
WAVELENGTH

FIG. 8 (a)

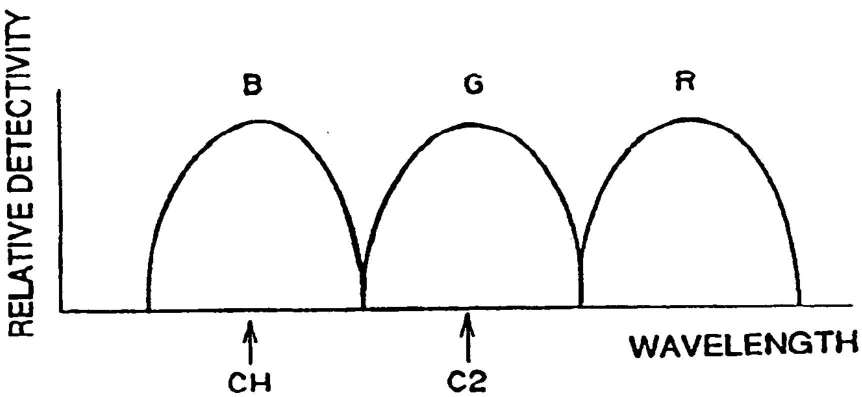

RELATIVE DETECTIVITY
B
G
R
WAVELENGTH
CH
C2

FIG. 8 (b)

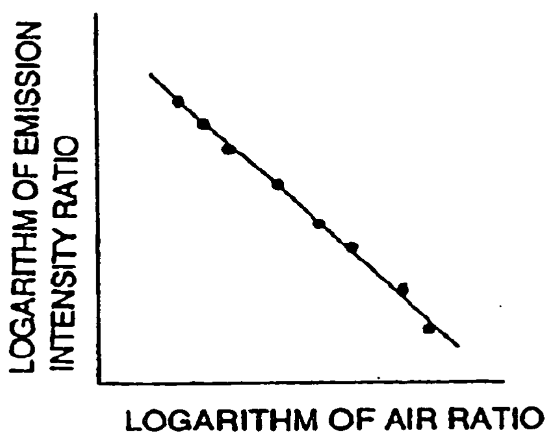

LOGARITHM OF EMISSION INTENSITY RATIO
LOGARITHM OF AIR RATIO

FIG. 9

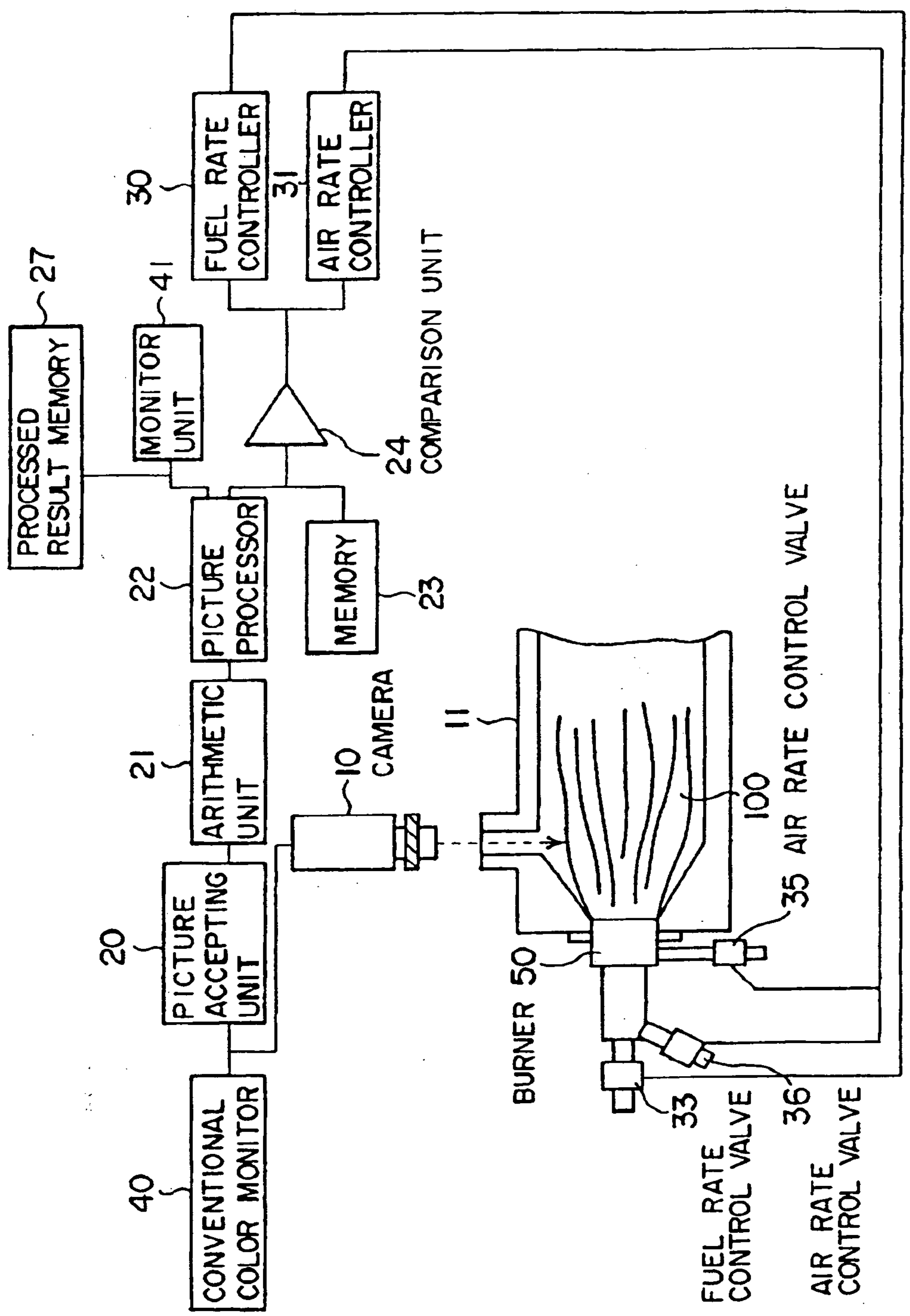

PROCESSED RESULT MEMORY
27
MONITOR UNIT
41
FUEL RATE CONTROLLER
30
AIR RATE CONTROLLER
31
COMPARISON UNIT
24
PICTURE PROCESSOR
22
MEMORY
23
ARITHMETIC UNIT
21
PICTURE ACCEPTING UNIT
20
CONVENTIONAL COLOR MONITOR
40
10
CAMERA
11
100
AIR RATE CONTROL VALVE
35
BURNER 50
33
36
FUEL RATE CONTROL VALVE
AIR RATE CONTROL VALVE

FIG. 10

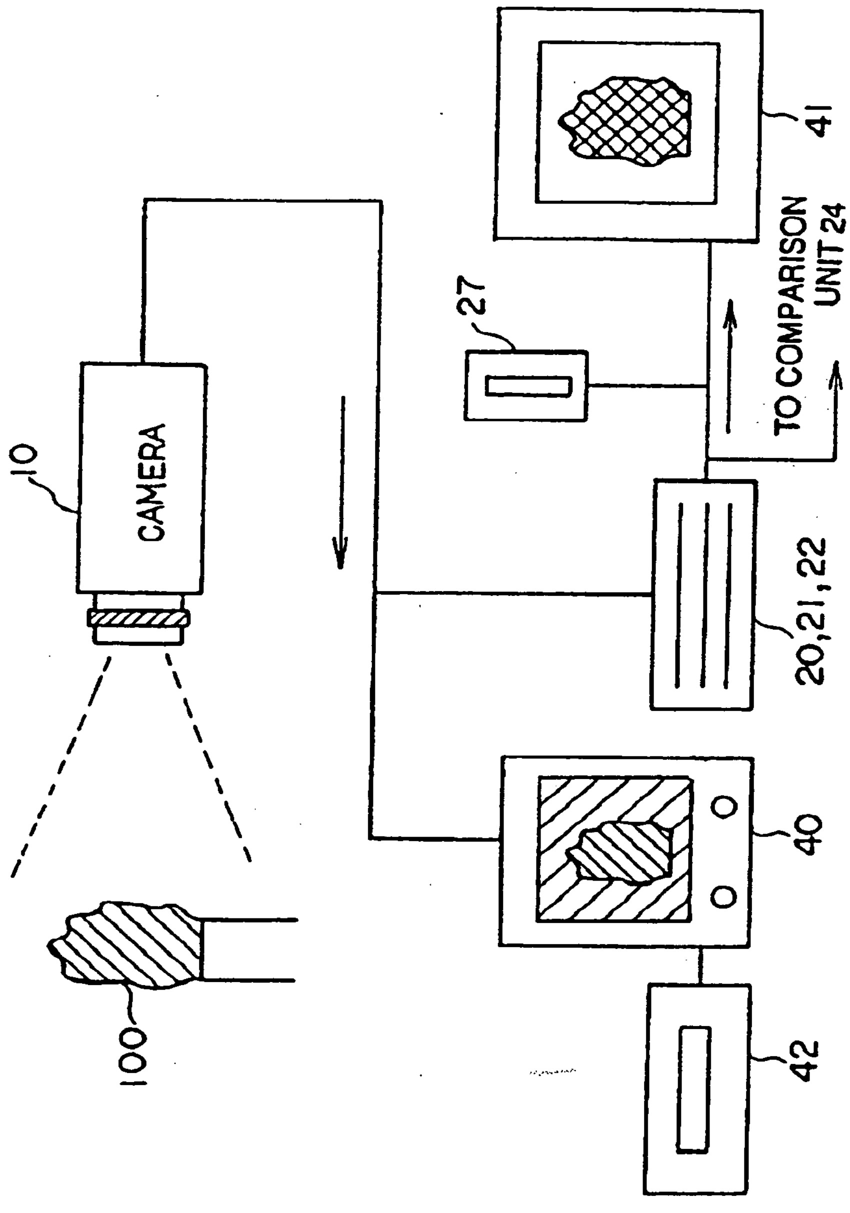


FIG. 11

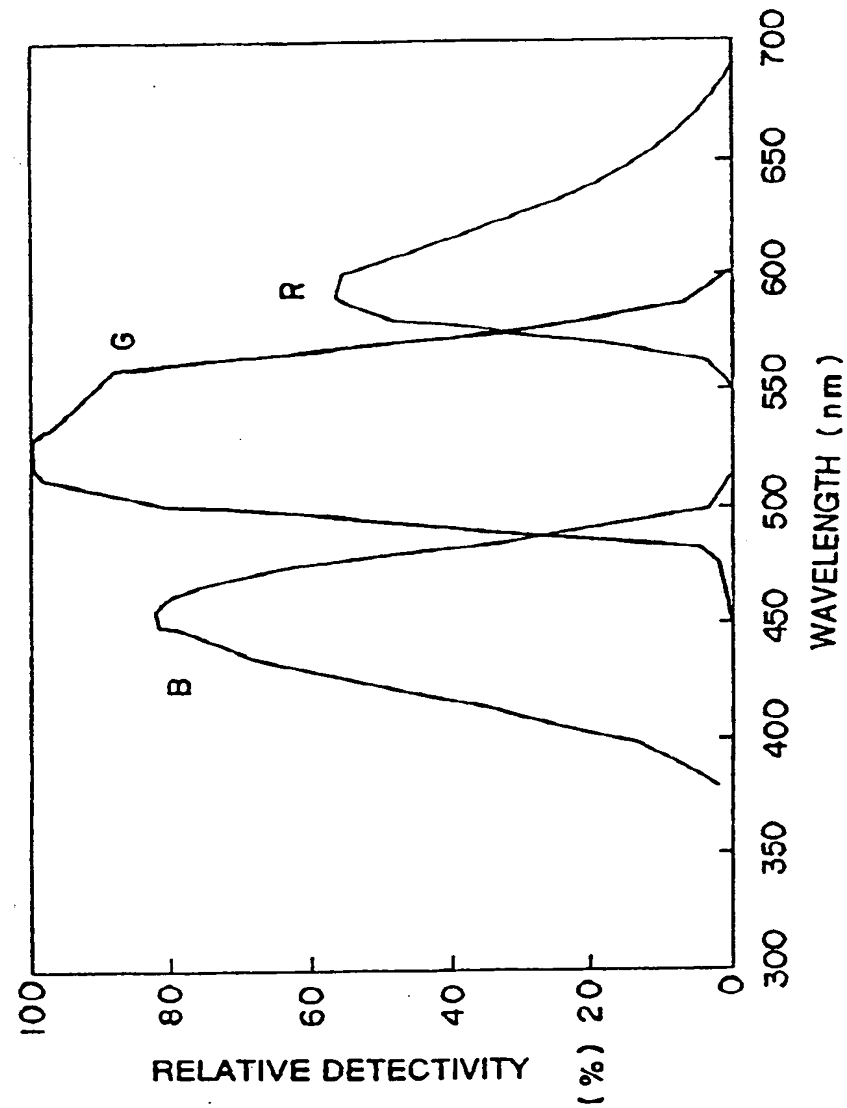

B
G
R
RELATIVE DETECTIVITY (%)
100
80
60
40
20
0
300
350
400
450
500
550
600
650
700
WAVELENGTH (nm)

FIG. 12

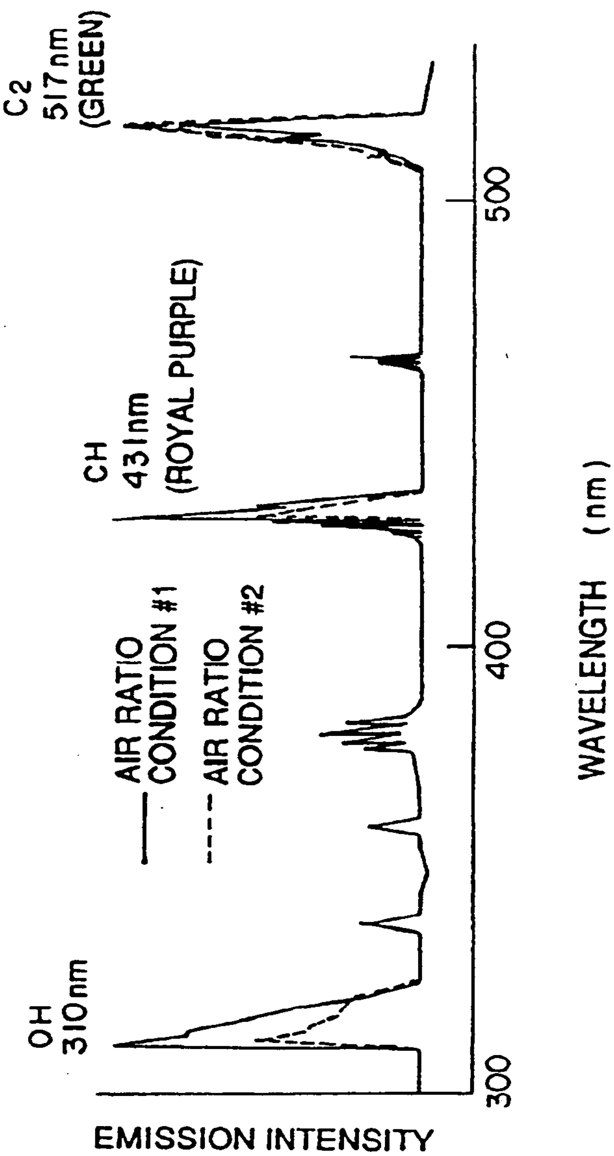

OH
310nm
CH
431nm
(ROYAL PURPLE)
C_2
517nm
(GREEN)
AIR RATIO CONDITION #1
AIR RATIO CONDITION #2
EMISSION INTENSITY
300
400
500
WAVELENGTH (nm)

FIG. 13

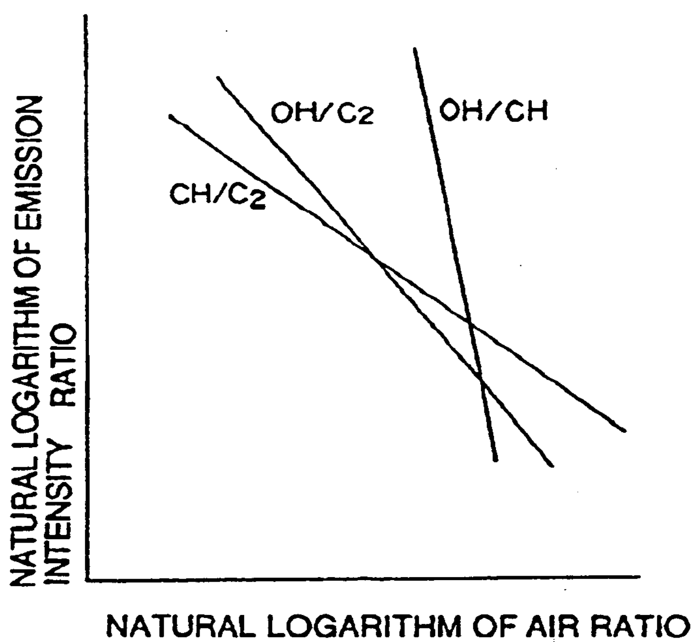

NATURAL LOGARITHM OF EMISSION INTENSITY RATIO
OH/C2
OH/CH
CH/C2
NATURAL LOGARITHM OF AIR RATIO

FIG. 14(a)

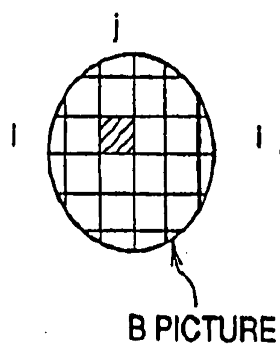


FIG. 14(b)

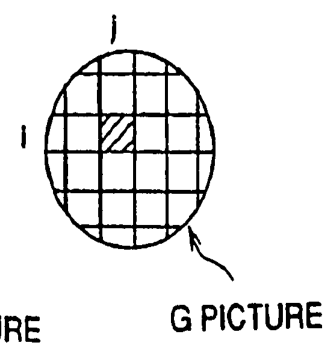


FIG. 14(c)

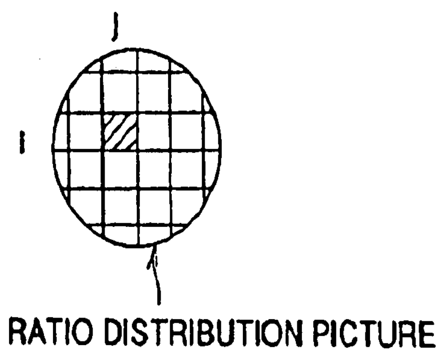


FIG. 15

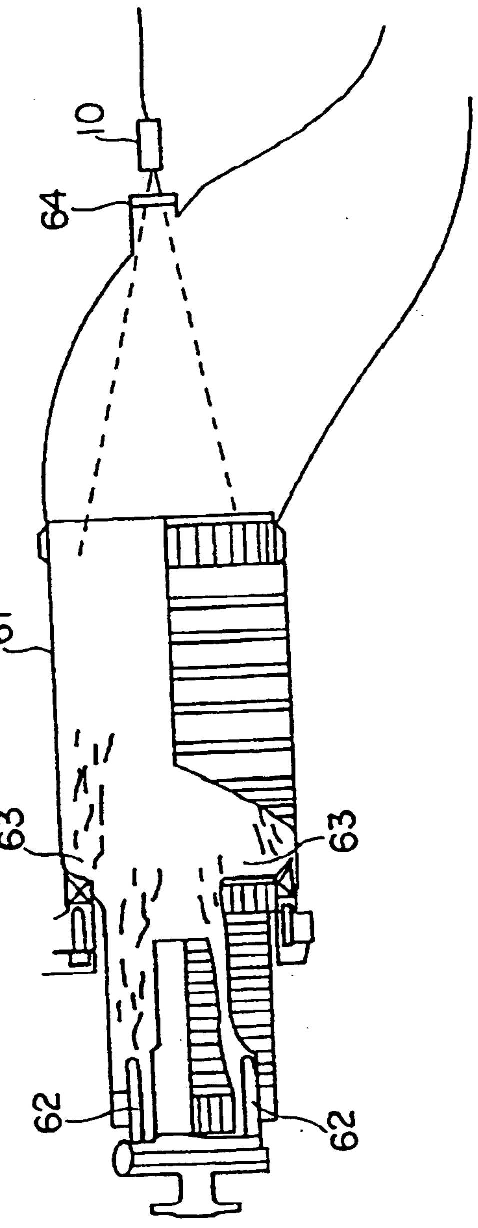


FIG. 16

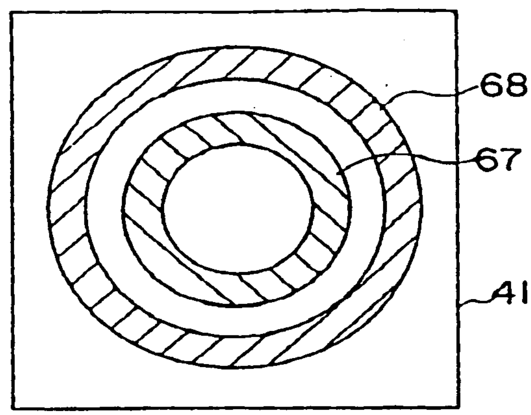


FIG. 17

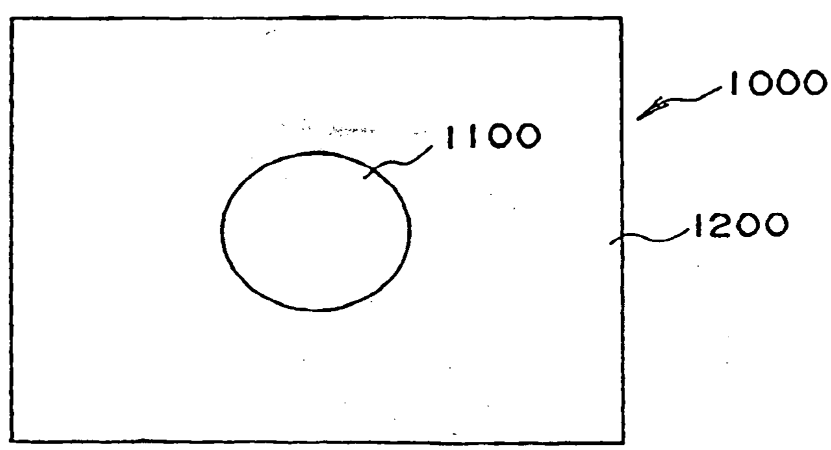


FIG.18(a)

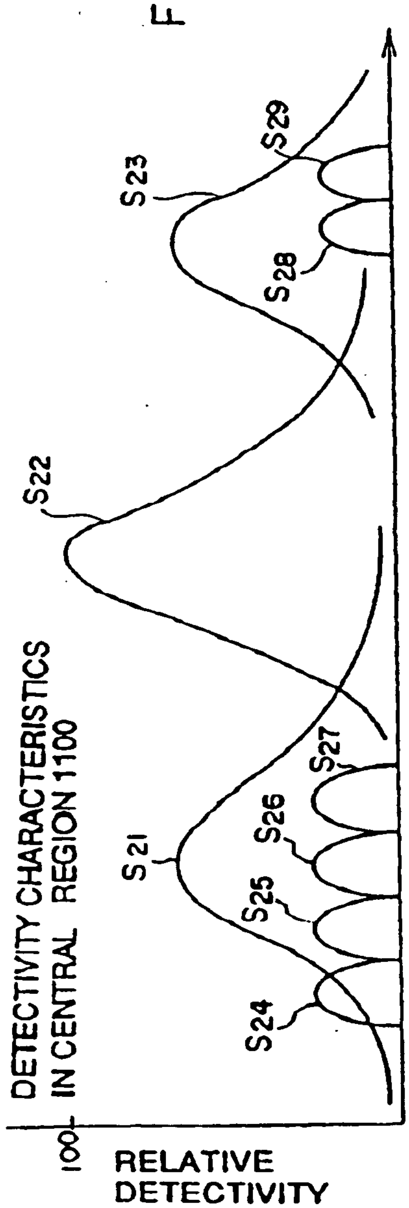
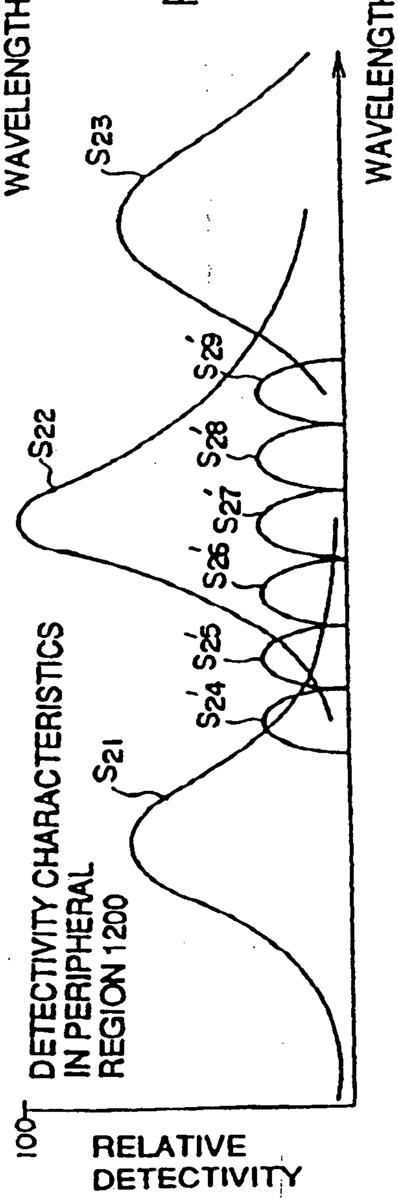


FIG.18(b)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 94104223.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	US - A - 4 596 930 (STEIL et al.) * Column 3, line 1 - - column 4, line 16; fig. 1-4 *	1-4 6-15, 17	G 01 J 3/36 F 23 M 11/04 F 23 N 5/08
Y A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 16, no. 507, October 20, 1992 THE PATENT OFFICE JAPANESE GOVERNMENT, page 11 M 1327; & JP-A-4-186 014 (HITACHI LTD.)	6-15, 17 5	
X Y	US - A - 4 913 647 (BONNE et al.) * Claims 1-19; fig. 1-5 *	16 6-15, 17	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US - A - 4 756 684 (NISHIKAWA et al.) * Column 2, line 58 - - column 7, line 5; fig. 2-8 *	6-15	F 23 M F 23 N G 01 J H 01 L
A	US - A - 5 133 605 (NAKAMURA) * Column 3, line 8 - - column 7, line 8; fig. 3-7 *	6-15	
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 11, no. 344,	6-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	03-06-1994	BAUER

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

-2-
EP 94104223.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
	November 11, 1987 THE PATENT OFFICE JAPANESE GOVERNMENT, page 33 M 640; & JP-A-62-123 218 (ISHIKAWAJIMA) --		
D,A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 15, no. 481, December 6, 1991 THE PATENT OFFICE JAPANESE GOVERNMENT page 154 M 1187; & JP-A-03-207 912 (HITACHI) --	6-15	
A	DD - A - 148 255 (MINISTERIUM FÜR NATIONALE VERTEIDIGUNG) * Pages 2-4; fig. 1 * ----	16	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

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